BRITISH SOCIETY
FOR THE
STUDY OF ORTHODONTICS

1964

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HEADQUARTERS

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THE TONGUE: THAT UNRULY MEMBER?

W. J. TULLEY, PH.D., F.D.S., D.Orth. R.C.S.

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THE title of this paper is a common misquotation of the passage from the Epistle of St. James: 'The tongue can no man tame, it is an unruly evil'. Does this apply to our field of endeavour?

Having been interested for some years in longitudinal studies involving both the form and function of the lips and tongue, I thought that a down-to-earth discussion on this subject would not come amiss. Although many of the younger generation of orthodontists are learning to assess the soft tissues according to a rigid formula, it is not possible to study these features with the same degree of accuracy as data derived from lateral skull radiographs of the facial skeleton. I have been conscious of how confused the student can get with this aspect of the subject.

The literature is now so extensive that it is difficult to review it adequately in a short space of time. Some of the significant work is to be found in the list of references. It varies from precise attempts at scientific measurements of adverse muscle forces using electronic aids, the electromyograph, and strain gauges. There is wealth of well-documented clinical data, but there has been some armchair speculation.

In fact, orthodontic problems associated with very adverse behaviour of the lips and tongue are not very common. Those orthodontists who have been sceptical of the work on this subject, have been looking at the total orthodontic problem and have been quite successful in a high proportion of their cases treated by well-tried empirical methods without giving much thought to the soft-tissue environment.

When I first visited the United States in 1956 there was comparatively little interest in this subject. When I returned in 1962 I found, as I suspected from the literature, a very great deal of interest in the role of the soft tissues in the aetiology of malocclusion. Dr. James Bosma had been appointed to establish a section of the National Institute of Dental Research to study oral and pharyngeal function in all its aspects. It was most stimulating to have the privilege of working with his team and to discuss our own work critically.

When I left Washington for the West Coast, I moved into the area where interest in this subject is at its height. Speech correctionists are taking a very active part in attempting to re-educate swallowing patterns as well as abnormal speech patterns before the orthodontist undertakes treatment of the malocclusion.

Straub (1960) is one of the chief exponents of re-educational therapy prior to orthodontic treatment. Straub's thesis is that bottle-feeding is one of the primary causes of retention of the so-called infantile aspects of swallowing and speech. There is little evidence to support this in data obtained in this country, as will be shown later. It is known that very few American children are naturally fed for any length of time, particularly on the West Coast. Rogers (1961) gives the figure of 5 per cent for children who were breast-fed in his population sample. Although Rogers casts doubts on Straub's theories, he shows that 56·9 per cent of a normal population sample have a tongue-thrust compared to 68·8 per cent in his orthodontic patients. As the late Professor Joad would have said: It all depends what you mean by tongue thrust.

The confusion of current terminology prompted a poem by Professor Bloomer entitled 'The Inverted, Perverted, Reverted Swallow'. In this same paper Professor Bloomer (1963) sums up the general view. He states: 'Some orthodontists and speech therapists are happy in their common endeavours in training patients to swallow. Others from both professions look on with a measure of disapproval. The concern represents not an antithesis to co-operation but an uneasiness about prescribing 'cookbook' treatment programmes for problems in which the dynamics of cause and effect are not yet understood'.

He goes on to say: 'The fact that a certain confusion of data and interpretations exists may derive from the very intricate nature of the phenomena that we are attempting to observe. Speech and swallowing are highly complex activities and both must be carefully studied before we can draw sound conclusions with reference to their cause and effect relationships.'

Few people in this country attempt re-educational exercises, but this is not for want of trying. Ballard and Gwynne Evans (1948) reported on the work of the Upper Respiratory Clinic where various remedial exercises were used.

Presidential Address presented at the meeting held on 13 Jan., 1964.

From clinical experience gained in the Upper Respiratory Research Unit at Guy's Hospital, where I was privileged to work with Mr. Rix and Mr. Gwynne-Evans, under the aegis of the late Professor Whillis and by following up many of our cases into the late teens, it has been found to join my colleagues who had arranged a clinical trial of fluoride toothpaste. The sample consisted of 1500 children of 11-plus years who had just entered secondary-modern, grammar, and comprehensive schools. Some of the larger schools had as many as 300 new entrants. They were

A

B

Fig. 1.—A, Example of a patient with pseudo-Class III malocclusion with tongue-thrust in swallowing and speech. B, The same patient after treatment. $\underline{21|12}$ have been moved over the bite and the tongue-thrust in speech has disappeared. (Extracted cine frames.)

that the best sensory cue for normal action of the tongue and lips is to put the teeth in as near normal a position as possible, within the limits dictated by the skeletal morphology (*Figs.* 1, 2). We have also learned not to treat patients too early before simple habit activities have modified naturally or disappeared completely. However, I think we may be justly criticized for not making more joint appraisals with speech therapists in really difficult cases before making pessimistic observations.

When I returned from the States, I was determined to assess for myself the overall need for orthodontic treatment in a large cross-sectional study of the child population. I was able scattered throughout south-east, east, and north London, and gave an excellent cross-section of London children at all levels of intelligence and social environment. This age-group was ideal as a fairly mature state of dental development had been reached.

Many members will know from experience that a survey of this kind is like having a baby. The labour is prolonged and when it is finished you sit back and think how wonderful it is and then the child grows and becomes more complicated, more demanding, and more difficult to understand. This survey is still in the adolescent stage. It will be partly longitudinal as well as cross-sectional.

In this paper I want to confine the discussion to practical aspects of the subject and not become involved in detailed statistics which will be published elsewhere. The assessment is perforce subjective, but to ensure relative accuracy a random 10 per cent have been rechecked and sure whether they would require treatment. He also admitted that he was setting an idealistic standard.

Of the cases requiring active orthodontic treatment only 71 of the 401 (17·5 per cent) showed adverse lip and/or tongue behaviour

A

B

Fig. 2.—A, Example of a patient with Class II, division 1 malocclusion, aged 7 years. *Note*: Very marked tongue-thrust in speech. B, Same patient, aged 17, five years after treatment which only partially corrected the overjet. *Note*: total relapse and persistence of tongue-thrust in speech. (Extracted cine frames.)

other observers are reviewing the material when it is studied annually.

Of the 1500 children, 401 (27·5 per cent) were assessed as requiring some form of active orthodontic treatment; of these 7 per cent required specialist orthodontic treatment, 8 per cent could be treated by the general practitioner with consultant advice, and 12·5 per cent could be treated by the general practitioner who has taken a special interest in orthodontics.

These figures compare favourably with other findings of the need for orthodontic treatment. They are lower than those presented by Gardiner (1956), but in his survey he was dealing with children over a wide age range, and admitted that 20·4 per cent of his subjects were too young to be which was likely to prevent a perfect result being obtained and in most of these cases a considerable improvement could be made. *Table I* shows how

Table I.—Analysis of Occlusal Abnormalities in 71 Cases with Adverse Tongue and Lip Behaviour

Class I	10
Class II, division 1	43
Class II, division 2	7
Class III	11

these cases were distributed in Angle's classification, with the expectedly high number of Angle's Class II, division 1 malocclusions (*Fig*. 3).

It is incredibly difficult to make rigid criteria for judging soft-tissue form and function which

can stand up to statistical treatment. For example, in judging whether the lips were able to effect an anterior oral seal without conscious effort, I had to watch some of the children for a considerable length of time.

These borderline cases are not really significant from the practical viewpoint, but my own figure of 54 per cent of children with incompetent lips is probably on the low side, particularly when compared to the figure of 80 per cent incompetent in a similar sample (Walther, 1960). This is one of the features which is being rechecked.

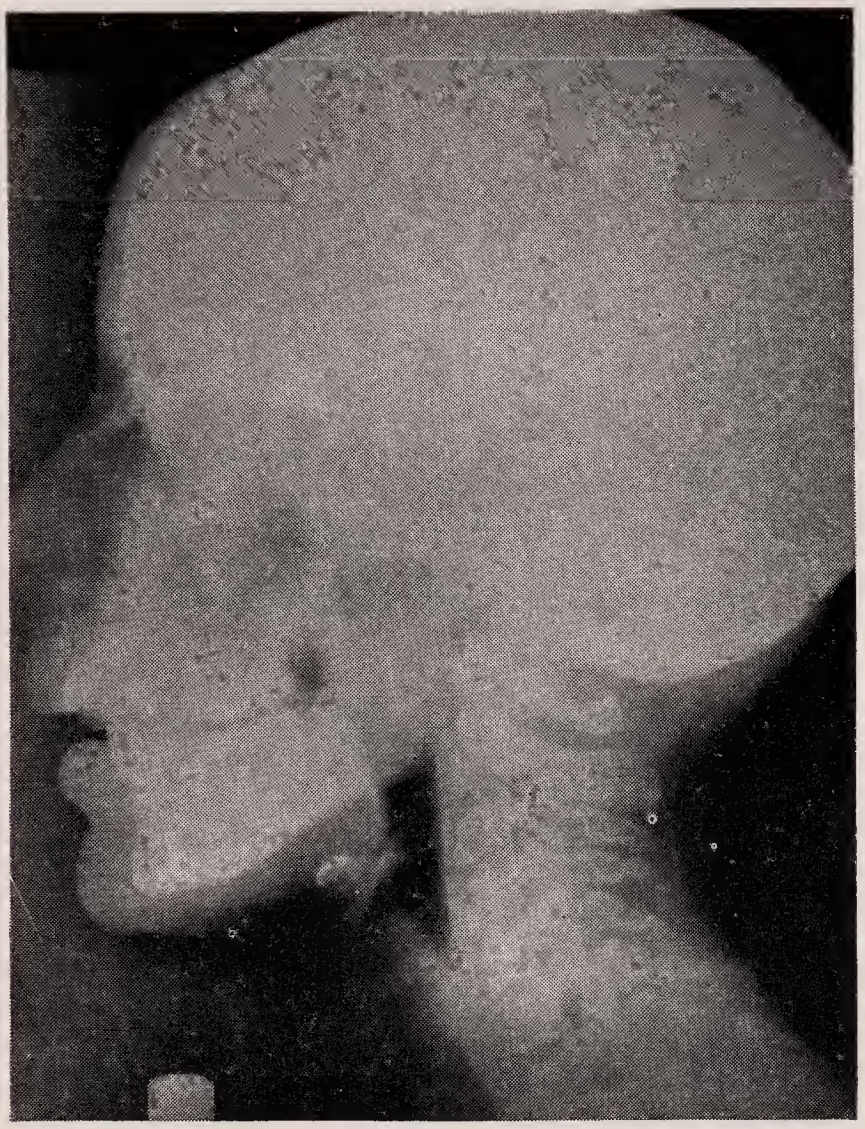
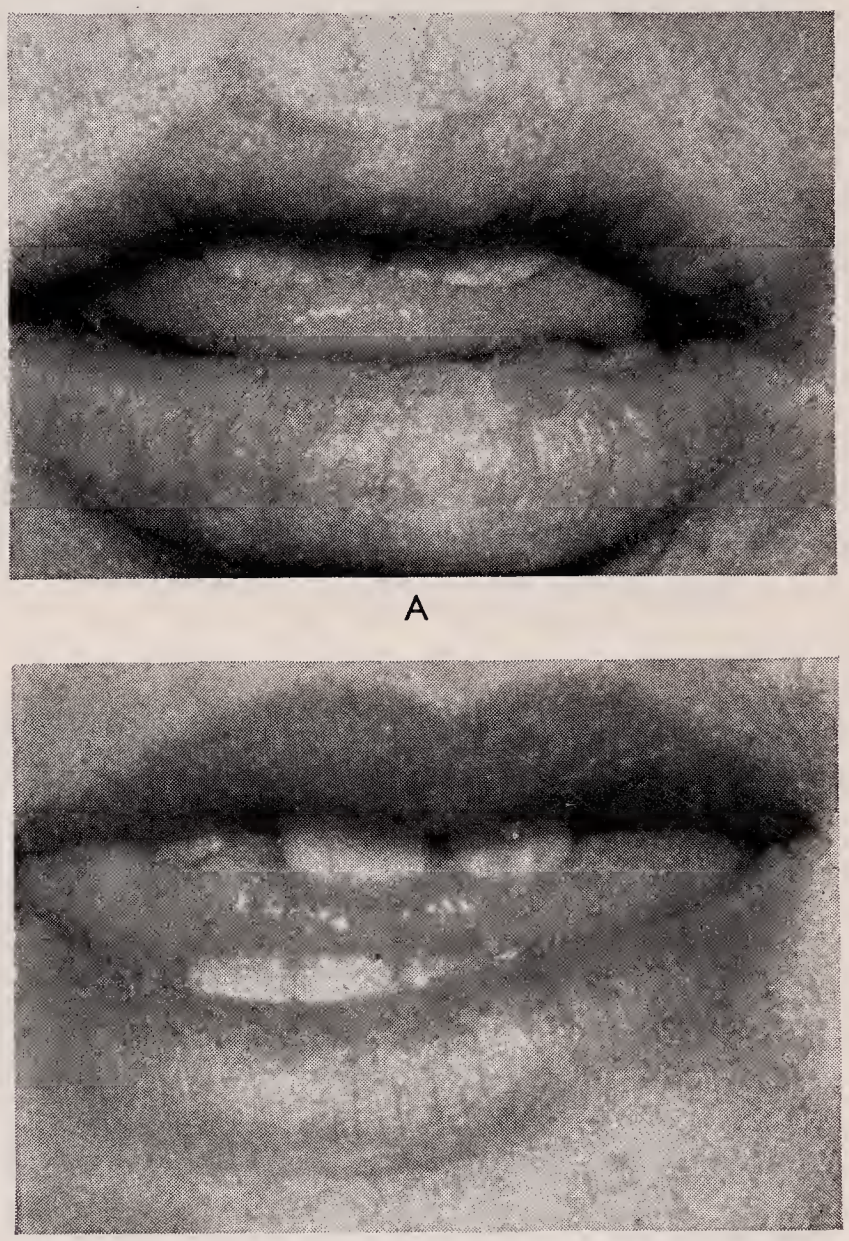


Fig. 3.—Example of one of the schoolchildren with Class II, division 1 malocclusion on a skeletal II dental base. The X-ray shows tongue-thrust in ' S ' sound.

With this difficulty of accurate assessment, I decided to narrow my interest to those children in this sample who have a lisp which was clinically obvious and where there was also some atypical action in swallowing.

Speech therapists recognize many forms of sigmatism, but, with the help of Mr. Robert Fawcus, selection was limited to those children with interdental sigmatism where the tip of the tongue pushed forward between the incisors and those where the blade of the tongue was forward, making contact with the upper incisal edge (*Fig.* 4). All these tongue positions were forward from the normal position for articulation of the ' S ' sound. Forty such cases appeared from the sample of 1500 (2·7 per cent). Only half of these required orthodontic treatment, so the significant figure in the total sample was only 1·35 per cent. Thus only 20 out of the number of cases requiring active orthodontic treatment had these adverse features (20 out of 401—5 per cent.).

Many more of the difficult cases with these adverse soft-tissue features are seen in hospital and specialist practice. This has led to a pessimistic attitude to these problems and a false view of their incidence. Therefore, it was decided to compare the 40 schoolchildren with a lisp and adverse swallowing action with 40 cases having the same criteria taken from hospital patients applying for treatment. I was able to collect these cases in a short time with the co-operation of a number of regional consultants who referred patients to me.



A

B

Fig. 4.—Examples of the two types of sigmatism selected. A, Tip of tongue obviously between upper and lower incisors. B, Blade of tongue under upper incisal edge, but tongue not over lower incisal edge.

METHOD OF EXAMINATION

These two groups of 40 children were examined more fully than the large sample. Cine films were taken of a number of the hospital patients and

they are being refilmed at regular intervals. This method of study is time-consuming and expensive. It was not applied to all the cases as the film material is difficult to document and reproduce in published evidence.

It was found possible to make records of all the children using an Edixa camera and Mecablitz flash (*Fig.* 5). With practice, representative pictures were obtained of the lips and tongue in the pronunciation of the ' S ' sound in sentences. It was also possible to record lip activity in swallowing (*Fig.* 6).

Table II shows an analysis of the morphological features of these two groups. Twelve of the school cases showed a good occlusion (*Fig.* 7). This is not entirely surprising as Tulley (1952; 1962), Ballard (1957), Hopkin and McEwen (1955), Subtelny and Subtelny (1962), and others have shown similar cases. It is certain that the explanation for this is that these subjects have an excellent facial development. In fact, 7 out of the 12 cases had a mild Skeletal III dental base relationship, which is well recognized as a feature of many cases with excellent occlusion (*Fig.* 8). Forward tongue-thrust in speech can be found where the overbite is deep. Rogers (1961) and others have reported such cases, and one was found in the school sample (*Fig.* 9). Froeschels and Jellinek (1941) explain such cases of normal occlusion and deep overbite as being merely that the mandible is lowered sufficiently to make way

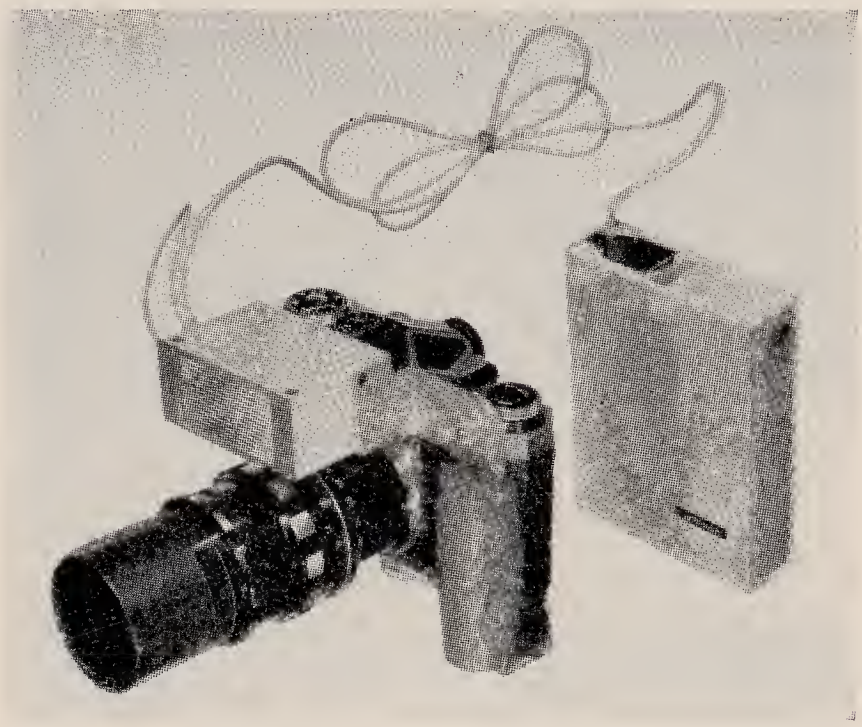
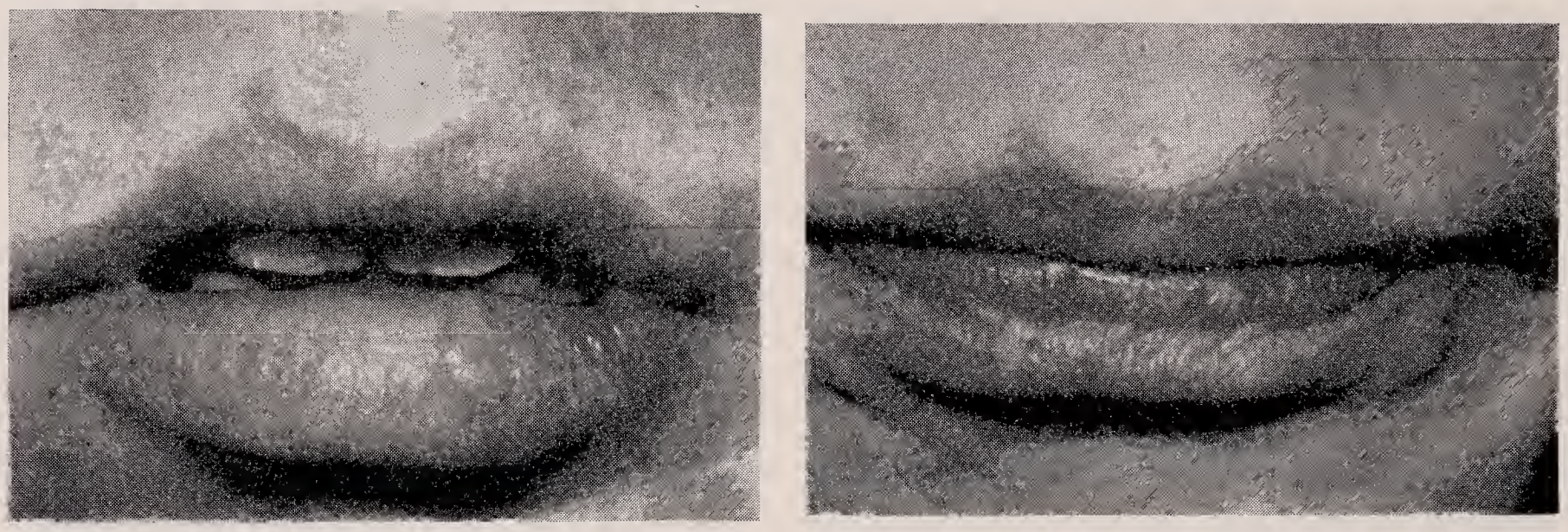


Fig. 5.—Edixa camera with extension tube for close-ups as shown in *Figs.* 4 and 6. Mecablitz flash with battery which can be charged from the mains.

Table II.—A Comparison of the Morphological Details in Hospital and School Groups with Adverse Behaviour in Swallowing and Speech

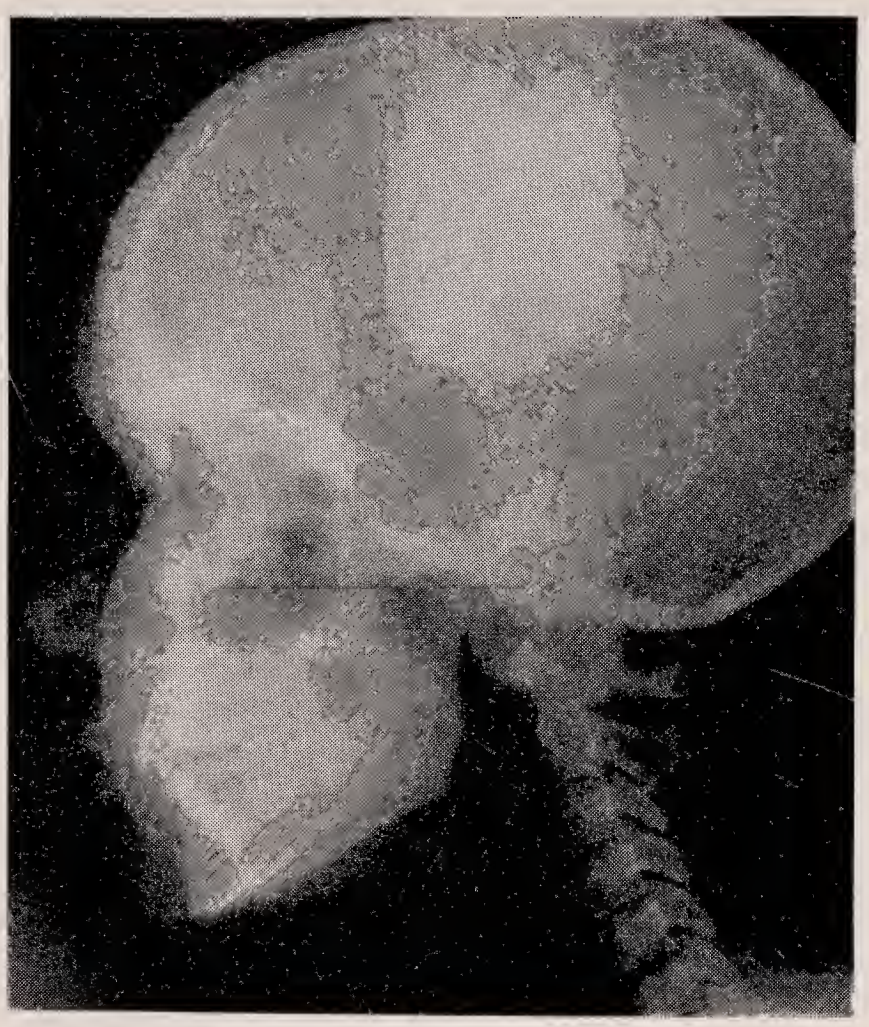
Hospital Group	Good Occlusion				Angle Class I				Angle Class II Division 1			Angle Class III			Total
	Nil				12				22			6			40
	Sk. I	Mild Sk. II	Sk. II	Mild Sk.III	Sk. I	Mild Sk. II	Sk. II	Mild Sk.III	Sk. I	Mild Sk. II	Sk. II	Sk. I	Mild Sk.III	Sk.III	
Skeletal class					1	5	4	2	2	11	9		3	3	40
Open bite					1	3	2	1	1	6	5		3	3	25
Incomplete overbite					—	2	1	1	1	5	3				13
Crossbite						1									1
High max.-mand.-plane angle					1	2	3	—	1	8	7		2	3	27

School Group	12				17				7			4			40
Skeletal class	4		1	7	9	2	1	5	3	3	1	1	2	1	40
Open bite					5			2		1					8
Incomplete bite						2		1		1	1	1	1		7
Crossbite					3			2	1	1					7
High max.-mand.-plane angle					2	1	1	1	1	1	1	1		1	10



A B

Fig. 6.—Examples of close-up pictures taken with camera, using Kodachrome II colour film. A, Lips at rest; B, Excessive contraction in swallowing.



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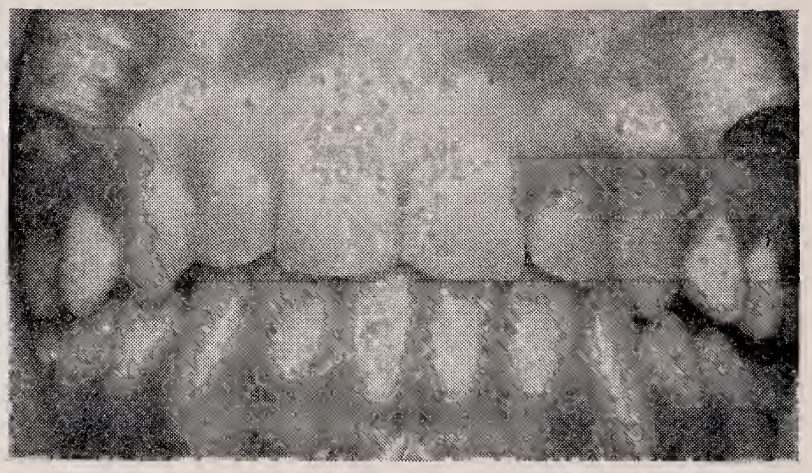


B

C

D

Fig. 7.—Example of a schoolchild with A, excellent skeletal form, B excellent occlusion, but with strong tongue-thrust in speech and circumoral contraction in swallowing (C, D).

for the tongue protrusion without affecting the teeth.

There was a very high incidence of open bite and incomplete overbite in the hospital group—38 compared with 15 in the school group. This finding agrees with Bernstein (1954) that with the classification 'open bite' there is a strong relationship with lisping, but this is the impression one gets from seeing only orthodontic cases. In fact, Bernstein does make the comment that children with speech defects do not have a greater amount of malocclusion than children without a speech defect.

Another clear fact was the incidence of a high maxillary-mandibular-plane angle in the hospital

group compared with the school sample. This was taken as being above 30°. Ballard (1959) has stressed the importance of this indication of mandibular shape in relation to tongue posture (*see below*).

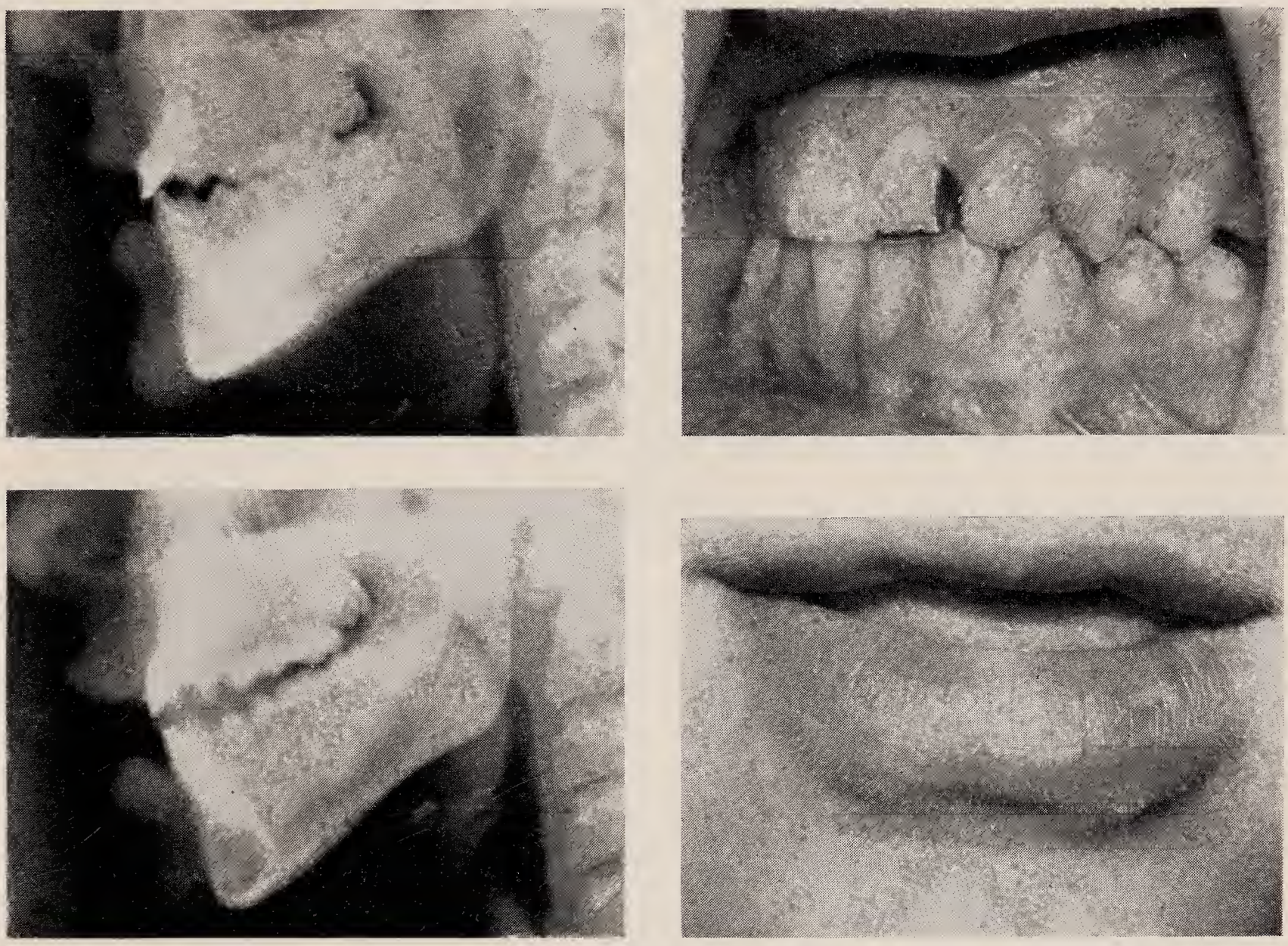


Fig. 8.—Example of schoolchild with a mild Class III tendency with reduced overbite and tongue-thrust.

Table III.—Data Derived from the Histories

	Hospital Sample per cent	School Sample per cent
Feeding difficulties	8	—
Bottle-fed only	32·5	29·5
Breast-fed only	35	29·5
Bottle and breast	32·5	41
Late talkers	5·4	6
Late walkers	—	—
Persistent colds and catarrh	30	27
Sucking habits beyond 6 years	60	20
Family history of lisp	30	26·5

Histories were taken from two groups in relation to feeding behaviour, milestones of development in locomotion and speech, upper respiratory symptoms, and whether there were any other members of the family with a similar speech defect (*Table III*). This revealed that only 8 per cent of the hospital cases and none of the school cases had any feeding difficulties in infancy. The figures for bottle-feeding, breast-feeding, and a significant mixture of the two were quite closely related in both groups. Only a very small percentage in both groups showed any delay in talking. The figures for severe upper respiratory symptoms were very similar and do not deserve comment.

There was a family history of lisping in 30 per cent of the hospital cases and 26·5 per cent of the school cases. These figures are probably lower than those that could have been obtained if all the parents and relatives had been examined. As many as possible were seen and records taken (*Fig.* 10).

In the hospital sample 60 per cent had a history of sucking habits beyond 6 years of age compared with 20 per cent in the school sample.

The modern trend has been to swing away from the consideration of sucking habits as a

primary aetiological factor. While this aspect received undue prominence in the past, we cannot altogether ignore persistent thumb-sucking in the overall picture of the difficult cases represented by this hospital group (Blyth, 1959).

A test for stereognosis (the sense by which form of objects is perceived) was suggested by one of Dr. Bosma's assistants, Dr. Grossman, who is now carrying out a survey of sensory appreciation in the mouth. The test was carried out by using a series of small plastic shapes. Each shape was concealed from view and placed in the front of the mouth for 3 seconds and the patient then asked to point to the shape on a card. Both groups were compared with a group of 40 dental students with no speech defect (*see Table IV*).

It would be unwise to speculate on the significance of these results, but the hospital group scoring was poorer than the school group, where there were less morphological abnormalities, and the same applies when the school group is compared with the students.

There is a great paucity of literature on the normal sensory appreciation in the oral cavity.

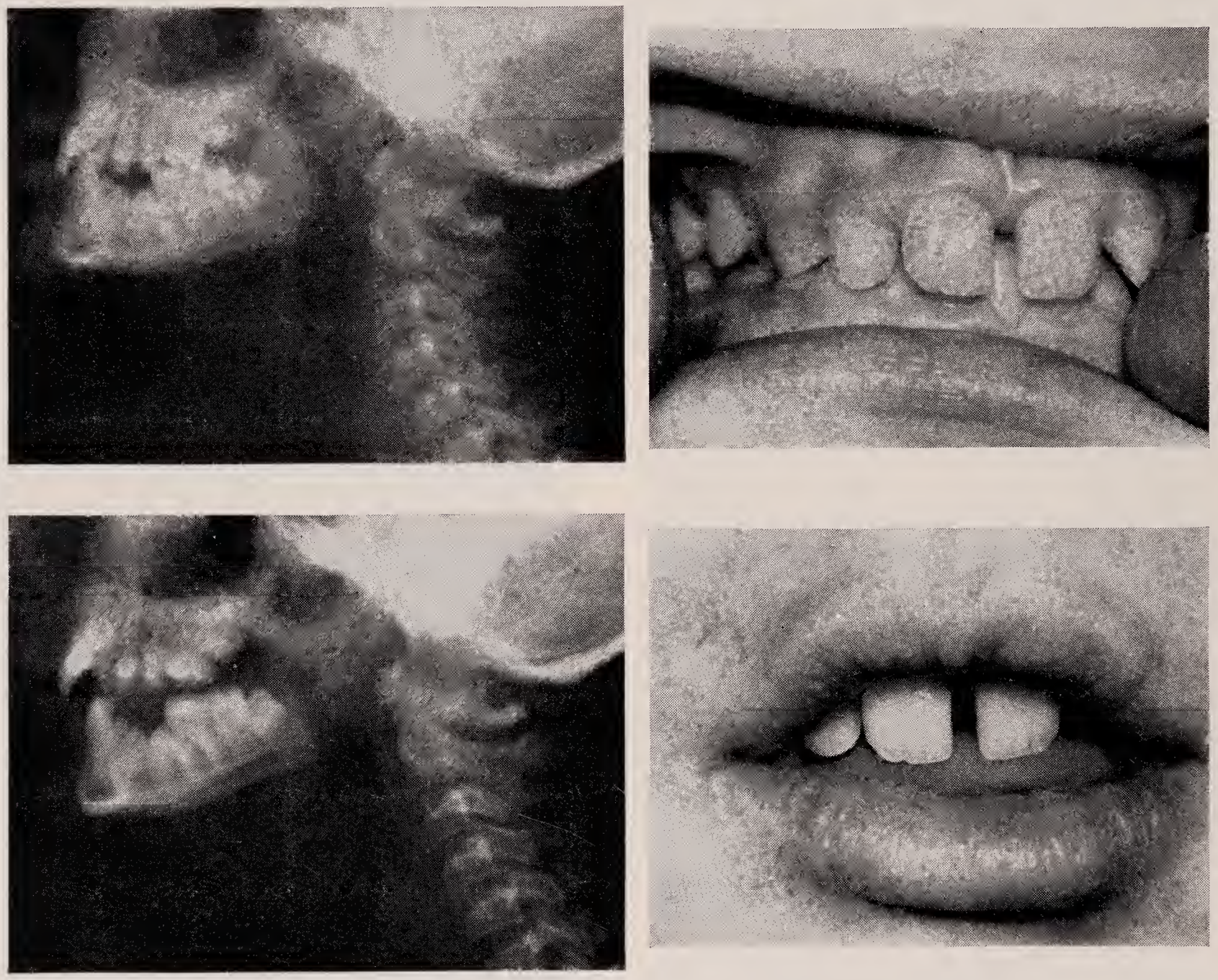


Fig. 9.—Example of schoolchild with deep overbite, but forward tongue-thrust in speech and swallowing. Note how the mandible is lowered.

Table IV.—Results of Stereognosis Tests

Score	10 Excellent	7–9 Good	5–6 Poor	Below 5 Very poor
Hospital	9 per cent	50 per cent	29 per cent	12 per cent
School	16 per cent	62·5 per cent	12·5 per cent	9 per cent
Students	25 per cent	60 per cent	15 per cent	—

It was only a relatively short time ago that intrinsic proprioceptive mechanisms were demonstrated in the tongue musculature of *man* by Sybil Cooper (1953) and others. Froeschels (1937) did refer to a clumsy tongue when he

Fig. 10.—Mother, daughter, and son all with lisping speech. Father and younger son have a normal occlusion. Note the daughter has a Class II, division 1 malocclusion with persistent lisp. The son has a Skeletal III dental base relationship with anterior open bite. Note similarity in lip morphology. (Extracted cine frames.)

discussed sigmatism. MacEwan (1962) and others have suggested that all these children would have diminished gag reflexes. I have not investigated this point.

We cannot entirely ignore the problem of tongue size as well as its posture and function (*Fig.* 11). In the case illustrated there is obviously

a very large tongue, but no one has found a really satisfactory method of assessing tongue size in relation to the size of the oral cavity. Certainly the lateral skull radiograph only gives a two-dimensional view. Tongue size is not an important factor in most cases. The tongue is never so large that it completely fills the oral cavity, but a large tongue may affect its posture and ease of manipulation. A large tongue is often seen with a large and adequate oral cavity as part of the developmental pattern. Brodie (1953) has shown a remarkable case, that would have been

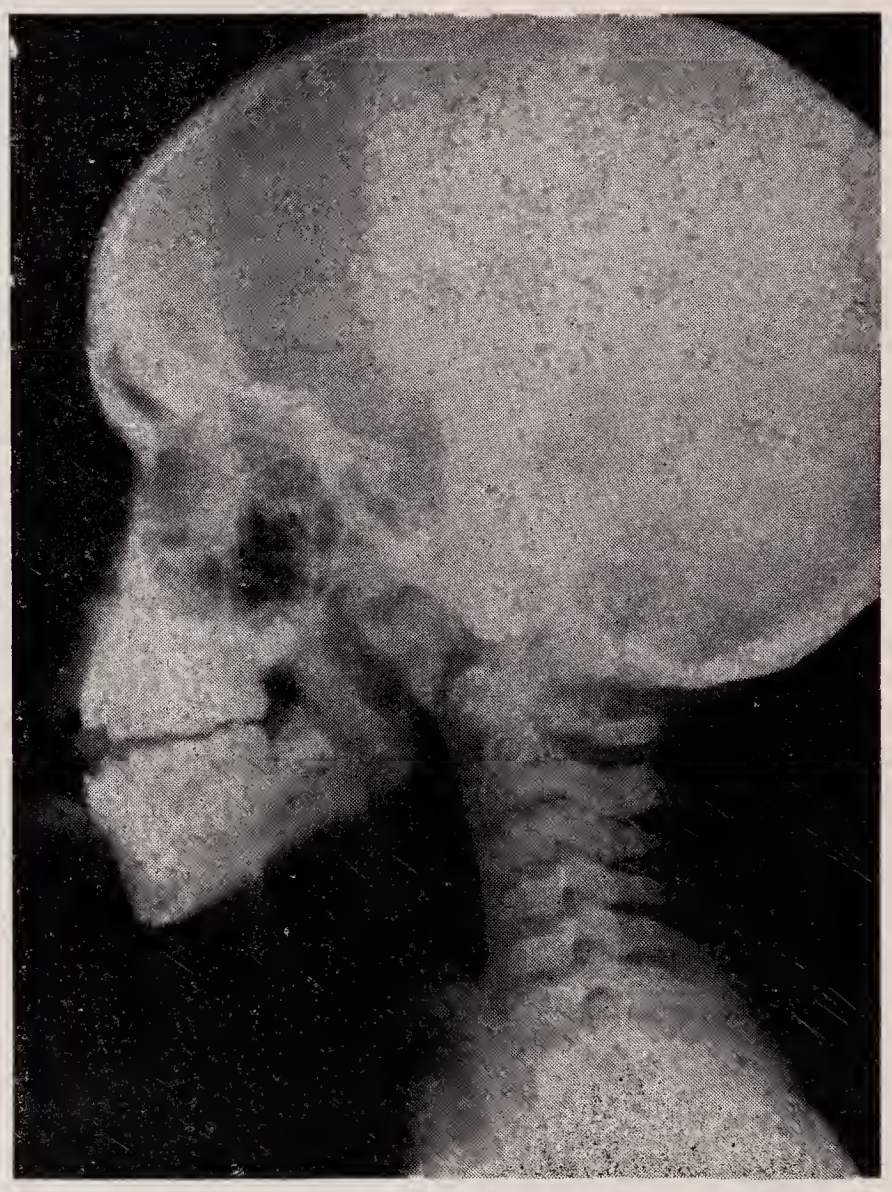
labelled as macroglossia, grow to accommodate the tongue with ease. The main difficulties arise where the upper jaw is small and a large tongue develops with a large mandible in a Skeletal III type.

The deeper one delves into the literature the more complex are the factors which can be held responsible for tongue-thrusting in speech. No doubt a small number are due to a receptor defect, poor auditory perception, and high-frequency loss (Morley, 1957). Other investigators indicate various defects in central control (Shelton, Haskins, and Bosma, 1959). Hopkin and McEwen (1957) quote Darlington and Mather (1949) suggesting a minor variation in cortical control which may be inherited. Bloomer (1963) goes so far as to suggest evidence of some patients having dysdiadokokinesia or lack of ability to perform consecutive movements in a controlled way, which could indicate a cerebellar defect. Van Thal (1954) and Hopkin and McEwen (1955, 1957) are among many who place emphasis on this type of behaviour as a sign of some psychological significance.

From the findings of this survey one must not consider most of these tongue-thrusts as having any pathological origin any more than we consider pathological factors to be responsible for the infinite variations of facial and dental form. The term ' diagnosis ' should be eliminated from the orthodontic literature and be replaced by the term ' case assessment '.

It is interesting to note that children with a speech defect in the English language sometimes find greater facility with another language. Ballard's fascinating study of facial form and language is intriguing, and it is to be hoped we will hear more of this.

A



B

Fig. 11.—A, Patient with large tongue. B, Lateral X-ray of this patient with tongue lolling forward at rest.

At the risk of over-simplifying the problem, clinical evidence justifies this statement:—

Tongue-thrusting with lisp is usually due to one or more of the following: (1) Pure habits; (2) ' Built-in ' behaviour patterns of genetic origin (endogenous) ; (3) Adaptive behaviour patterns.

HABIT ACTIVITIES

This term should be distinguished from Ballard's term ' habitual ' which he uses in relation to adaptive behaviour which is reflexly established. It is intended here to refer to tongue habits which are residual childish activities. These habits are given up in due course, and any resulting open bite disappears, if there is no underlying skeletal discrepancy or lip trapping.

BUILT-IN BEHAVIOUR (ENDOGENOUS)

The origin of this behaviour may lie in an obscure inherited central variation already referred to. The important clinical implication is that this tongue behaviour will not, in itself, affect the treatment of any malocclusion where the skeletal structures are of good proportions. If a mild open bite is present it may disappear by 11 years of age. Ballard (1957) has made this point very clearly, but it has not been generally appreciated that the label of ' endogenous '

tongue-thrust based on clinical assessment and family history does not, in itself, indicate a poor prognosis for the treatment of an associated malocclusion.

ADAPTATIVE TONGUE BEHAVIOUR

The majority of cases which become the concern of the orthodontist may fall into this group. Ballard (1959) has shown that where there is a skeletal discrepancy associated with a high maxillary-mandibular-plane angle the tongue may adopt a resting position forward from its innate posture (*Fig.* 12). This enables an anterior oral seal to be achieved when the lips are incompetent. This forward resting posture

Fig. 12.—X-ray of patient with high maxillary-mandibular-plane angle showing forward resting position of tongue.

fosters a forward movement of the tongue, both in swallowing and speech.

If the skeletal discrepancy is not so great as to prevent a reasonable incisor relationship being established, the prognosis is not so poor and the adaptive behaviour disappears with orthodontic treatment. Where the morphological factors do not allow a better incisor relationship to be established this is the primary reason for the poor prognosis.

It is possible that the really difficult case has not one but many of these factors making for poor tongue control. Only 10 cases were found where this might apply in the total sample of 1500 (0·66 per cent).

It is possible to build up a composite picture of the facies of these subjects, as shown by the artist's impression of two basic types in *Fig.* 13. These are shown with some of the actual cases from the school and hospital sample.

There is no simple common denominator, apart from the discrepancy in jaw relationship (Skeletal II or Skeletal III) with a high maxillary-mandibular-plane angle. There is a flaccid, somewhat coarse or heavy middle third or lower half of the face. The lips are nearly always

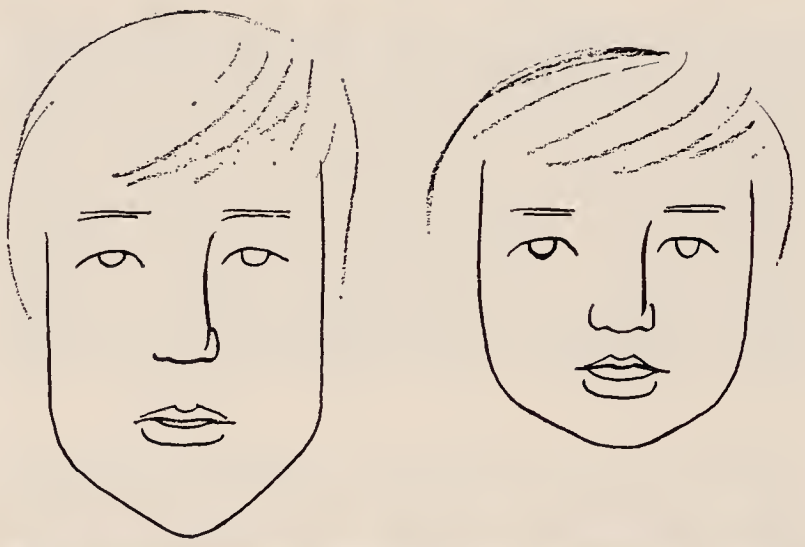


Fig. 13.—Artist's impression of the facies of the problem case with a selection of actual cases from the hospital and school groups. The two lower pictures are brother and sister.

incompetent. These patients often look mentally dull, but there is no link with intelligence level as many were found to be extremely clever and the distribution quite even in grading at school.

(A film was shown at this stage to illustrate various cases of this type together with their parents and other members of the family.)

CONCLUSIONS AND SUMMARY

This paper has merely tried to put in perspective many theories on tongue and lip activities in relation to dental arch form.

Where a malocclusion exists and there is a tongue-thrusting behaviour in speech and other functions, this is not necessarily a poor prognostic sign. It is clear that speech defects of this type may not be the primary cause of a malocclusion. It is also clear that a malocclusion is rarely the primary cause of a speech defect (Froeschels, 1937; Van Thal, 1954). These statements, however, must not be too dogmatic.

From the evidence, tongue-thrust behaviour of a severe degree can be found in subjects with an ideal occlusion. The basic inherent size, shape, and relationship of the skeletal structures must be a dominant factor establishing the occlusion of the teeth. The lips, cheeks, and tongue, also part of the inherent pattern, act as a rubber-like mould influencing the position of the dento-alveolar structures, developing on the jaw bases. Where the hard and soft tissues do not foster good occlusion of the teeth, adverse functions of the lips and tongue may be added complicating factors, completing the clinical picture of a patient where treatment of the dento-facial abnormality is likely to be extremely difficult. From this survey, it has been shown that there is only a very small number of such cases, approximately 1·35 per cent of the population sample.

The interest in soft-tissue behaviour which was 'sparked off' after the war by Rix (1946), Ballard and Gwynne Evans (1948), and others was a challenge to investigators and a welcome change from the empirical approach of cephalometric geometry. Rix no more meant this aspect of aetiology to be overplayed than did Broadbent expect his cephalometric research tool to become a rigid geometric exercise for diagnosis.

Acknowledgements

I would like to thank all my colleagues at Guy's, especially Mr. R. E. Rix and Mr. K. E. Pringle; Mr. E. Gwynne Evans and the late Professor Whillis for a stimulating liaison which prompted this work; Dr. James Bosma and his staff at The N.I.H., Bethesda; Professor Emslie and Dr. Naylor for allowing me to join their research team; Mr. Jones for advice on the photography and the prints of the colour slides; Miss Sylvia Treadgold for the artist's impression; Mr. Robert Fawcus, speech pathologist for assistance in selecting the material; Mrs. King and Mrs. Rawlins for the secretarial help during the survey; and particularly the parents and children who were so co-operative.

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AN ORTHODONTIC CASE TREATED WITH SIMPLE APPLIANCES

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I SHALL describe the case of a child whose parents have both worn full dentures since their twenties.

Details of the case and treatment form but one part of the story—an interesting ' dividend ' is the change of attitude now shown by the patient to dentistry.

CASE REPORT

No dental advice was sought until pain from a cariously exposed pulp brought the patient to my surgery, and led to the extraction of $\overline{|6}$ at the age of 7 years. Now, as a young, working adult, aged 18 years, the patient attends for regular dental inspection on his own initiative.

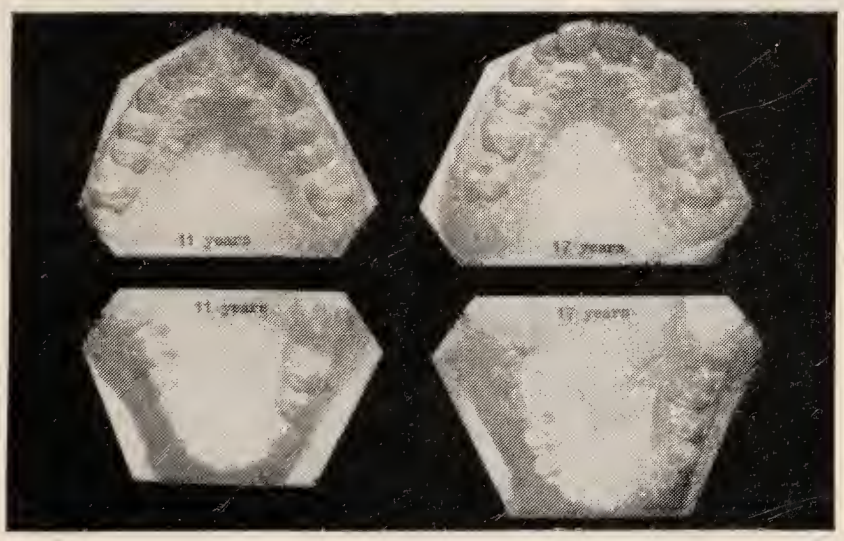
He is an only child whose birth was premature, and whose dentition is highly caries-prone. Following the initial treatment, which largely comprised the conservation of the remaining first permanent molars, I saw little of the patient for the next four years.

At 8 years he had fallen, fracturing $\underline{1|1}$.

Advice was sought again at 11 years, when his dental condition was as follows (*Fig.* 1):—

1. Class II, Division I malocclusion on Skeletal II base with overjet of 9 mm.

2. An abnormally small mandibular dental arch. Only the buccal surfaces of the lower posterior teeth occluded with the uppers at all, producing a wedging effect with consequent lateral expansion of the upper dental arch.



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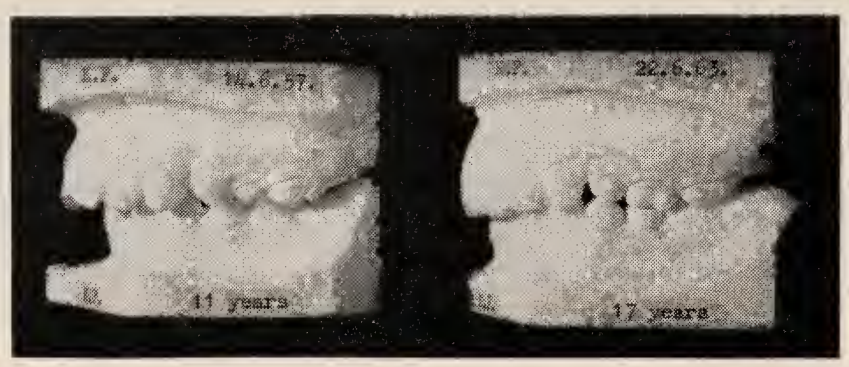

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Fig. 1.—Models of case before and after treatment. A, Occlusal view. At 11 years: Small mandibular arch (distance between buccal cusps $\underline{5|5}$ 13 mm. greater than between $\overline{5|5}$. At 17 years: Distance between buccal cusps $\underline{5|5}$ only 5 mm. greater than between $\overline{5|5}$. B, Left lateral view. At 11 years: 9 mm. overjet. C, Anterior view. At 11 years: Fractured $\underline{1|1}$. At 17 years: $\underline{1|1}$ restored by porcelain jacket crowns. Improvement in bucco-lingual occlusion, especially on left side.

3. A dead pulp in $\underline{|1}$, radiological evidence suggesting periapical infection and an incompletely formed root apex.

Root treatment and apical resection for $\underline{|1}$ were carried out and evidence of bony repair of this area awaited before orthodontic treatment was begun (*Fig.* 2).

Here, I should like to thank Mr. Rix for allowing me to admit the patient to the Children's Ward at Guy's Hospital, and for permitting me to undertake this treatment under a general anaesthetic in an operating theatre.

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Presented at the meeting held on 10 February, 1964.

The first part of the orthodontic treatment for the Class II malocclusion was begun four months later.

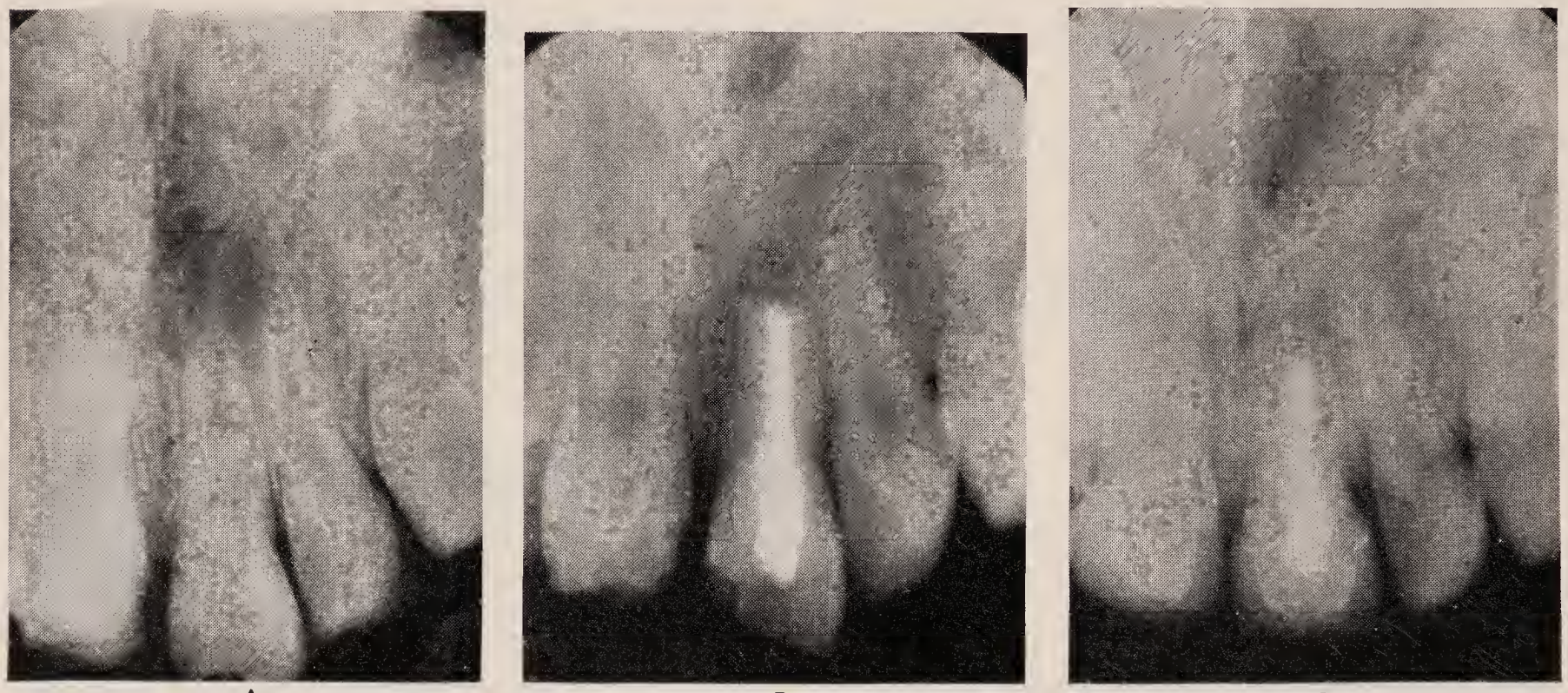
a. Extraction of $\underline{4|4}$.

b. Retraction of $\underline{3|3}$ using 0·6 mm. palatal springs while opening the bite on an inclined anterior biting surface.

c. Retraction of $\underline{21|12}$, using the same appliance. Acrylic was removed from behind the incisors to ensured that as lower lateral expansion was carried out, the wedging effect of the buccal surfaces of the lower posterior teeth was unable to produce further lateral expansion to the upper arch.

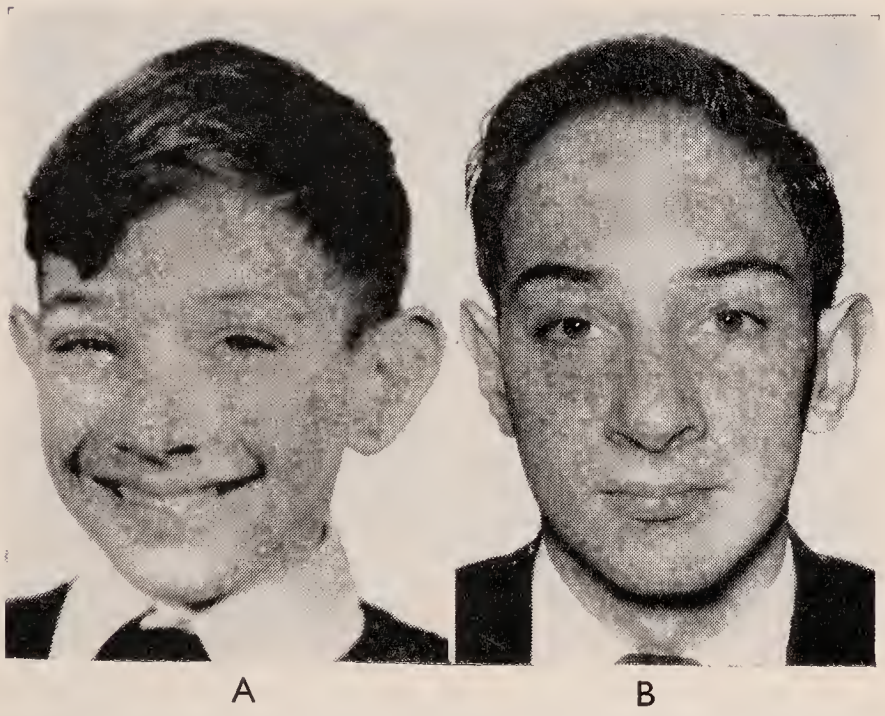
Finally, treatment for bucco-occlusion of upper posterior teeth completed the orthodontic treatment.

As soon as the treatment of the Class II malocclusion was completed, an upper contraction



A B C

Fig. 2.—A, Radiograph $\underline{|1}$ at 11 years, open apex, periapical area. B, Radiograph $\underline{|1}$ four months after apicectomy; bony repair beginning. C, Radiograph of $\underline{|1}$ at 18 years; satisfactory periapical bone pattern.



A B

Fig. 3.— A, Parents' snapshot of patient at 10 years. B, Patient at 18 years.

form a saddle plate and the labial bow split to form two buccal arms.

Treatment of the Class II malocclusion occupied 8 months.

The second part of the treatment was for linguo-occlusion of lower posterior teeth.

Six weeks after fitting the first appliance a lower expansion appliance, using a small Glenross screw set lingually to $\overline{21|12}$, was fitted. The upper appliance

Fig. 4.—Crowns restoring $\underline{1|1}$ at 18 years.

appliance was fitted and was used concurrently with the lower expansion appliance. This appliance was made in two halves, connected by a Glenross screw in the open position, with a 5 mm. separation down the centre of the palate. A split labial bow was used to retain $\underline{21|12}$ during the upper contraction.

Second upper and lower screw appliances were required before normal lateral occlusion was reached. In addition, the screw in one upper appliance was reset for further contraction directly in the mouth using cold-curing acrylic. In this way, a movement equal to the complete travel of three upper and two lower screws was required. A total of three upper and two lower removable appliances was used for

the whole treatment. Appliances were worn for 2 years, 2 months from the age of 11 years 10 months to 14 years.

Photographs of the boy before and after treatment are shown (*Fig.* 3) and of the anterior teeth after treatment (*Fig.* 4).

Acknowledgements

I should like to thank the Dental Photographic Department of Guy's Hospital, especially Mr. Jones, for his assistance, and our President for inviting me to present the case.

DISCUSSION

Mr. B. C. Leighton asked Mr. Kerr whether, at a later date, he had had to extract any teeth from the other side of the lower arch. He noticed that Mr. Kerr had a lower first molar extracted from one side and two upper molars. He himself found that it was often necessary to remove the lower second molar on the other side.

Mr. J. S. Rose asked if Mr. Kerr had difficulty in preventing a wedging action of the lower arch against the upper when he was expanding it. In two cases of his own, he had found that he had continually to add to the anterior bite plate to stop this kind of problem.

Mr. T. Smith asked Mr. Kerr what criteria led to the choice of a general anaesthetic for the apicectomy, and was there any other way of dealing with this tooth before treatment?

Mr. Kerr, in reply to Mr. Leighton, said that he had not, as yet, taken out any other lower tooth on the other side, but he said that he fully agreed with Mr. Leighton that, often, in these Class II cases, crowding of the lower arch resulted. The patient was only 18 years and he was keeping an eye on that. The third molar had not yet erupted and he thought there would be room for it, in fact, and it would not have to be taken out.

With regard to Mr. Rose's question about the wedging action, he thought it vital to have an upper appliance in to prevent further expansion in the upper arch during the lower arch expansion. In this case, he had not run into any very great difficulties over this problem. He had started the lower expansion as soon as he could and the anterior biting surface was causing gagging of posterior teeth.

In reply to Mr. Smith, he said that the patient had been 11 years old when the decision about root treatment was made. He always felt that apicectomy was one of the least satisfactory operations in oral surgery to have to do under local anaesthesia.

A COMPARATIVE STUDY OF INTERMAXILLARY SPACES WITH TREATED AND UNTREATED OCCLUSIONS

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INTRODUCTION

The shape and dimensions of the intermaxillary space and the relationship of the dental bases are inherited. The soft tissues mould the dento-alveolar structures which are physiologically plastic and adaptive as they grow from the dental bases to establish an occlusion (Ballard, 1963). Parker (1963) compared the intermaxillary spaces of two groups of children. The first group had abnormal occlusions (Class II, division 1), the second group was selected at random in order to assess the normal (mean) intermaxillary space for the population. He found that the average shapes of the intermaxillary spaces and therefore the relationship of the dental bases were different in the two groups. Within the intermaxillary space it was found on average that although the development of the dento-alveolar structures was abnormal in the incisor region it was normal in the molar region. The detailed abnormality in the incisor region supported the view that in the Class II, division 1 type of incisor relationship the vertical development of the upper incisors is prematurely arrested on the lower lip (Ballard, 1960), whereas the lower incisors develop an excessive amount (Ballard, 1957) until they usually contact the palate. The fact that the development of the dento-alveolar structures was abnormal only in the incisor region prompted Parker (1963) to suggest that in general the treatment of Class II, division 1 occlusions should be directed to repositioning the upper and lower incisors with no attempt to change the relationship of the dental bases or the level of occlusion in the molar region.

In the present investigation the intermaxillary spaces of two groups of children were assessed and compared. The first group with Class II, division 1 occlusions was assessed before treatment, after treatment, and out of retention. These findings were then used to calculate the changes between the three stages. The second group selected at random was untreated, these were assessed at two different ages to give the features of the normal (mean) intermaxillary space for the population and the normal (mean) growth changes. The evaluation of the overall effects of treatment is important in determining whether the soft tissues are a factor in the production and stable correction of the Class II, division 1 occlusal abnormality. These findings in turn help to clarify the objectives of treatment. A comparison between the overall changes in the treated group and the growth changes in the untreated random group indicates the extent to which the pattern of growth in the Class II, division 1 occlusions is influenced by treatment. The assessment of the short-term changes shows whether treatment produces wider changes than those observed in the long term. In the short-term changes particular note was made of the changes produced by bite plates and banded appliances. This knowledge helps in the selection of the appropriate appliance for a particular occlusal abnormality. The changes which occur as the occlusion settles after treatment show whether there is any tendency to revert to the original pattern of development. These findings in turn point to the factors which control development and define the limits of treatment.

MATERIALS AND METHOD

The children studied were those reported on by Parker (1963). The two groups were:—

1. A random group of 33 children with varying occlusions.
2. A group of 31 children with Class II, division 1 occlusions who received orthodontic treatment.

The average ages when the radiographs were taken for the random group were 10 years and 14 years 7 months.

The group with Class II, division 1 occlusions had radiographs taken before treatment, at the

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Second Chapman Prize Essay, given at the meeting held on 10 February, 1964.

end of active treatment, and out of retention. The average period of retention after active treatment was 5 months. The third radiograph was not taken until at least 9 months had elapsed since appliances were discarded. The average period was 3 years. The average ages when the radiographs were taken were, 11 years 8 months for the first, 14 years 2 months for the second, and 17 years 6 months for the third.

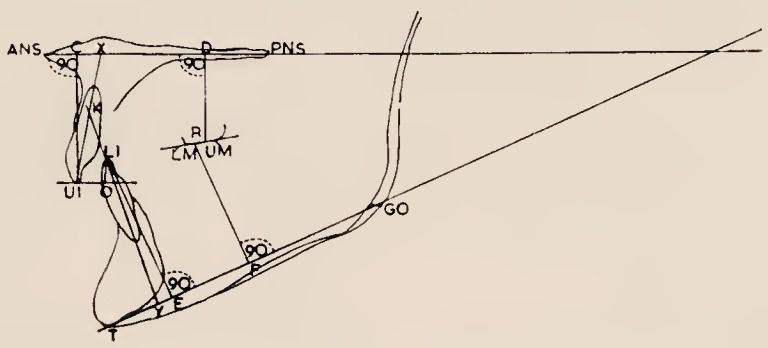

Fig. 1.—Diagram of reference points and planes.

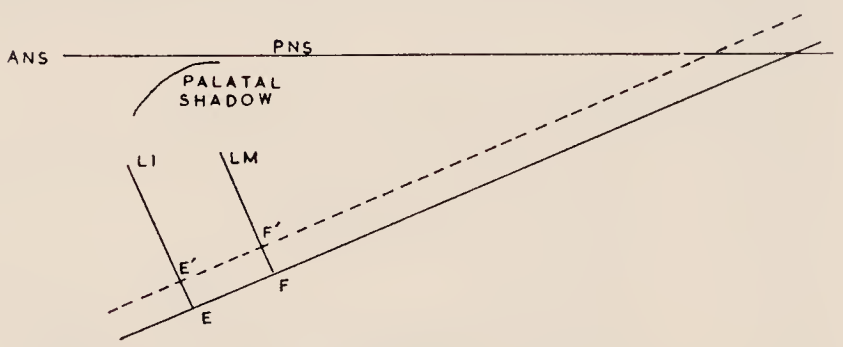

Fig. 2.—Diagram showing the method of superimposing tracings to calculate changes in the height of the molar and incisor regions of the intermaxillary space.

There were differences in the treated and untreated groups in the number of extractions carried out, the treated group having considerably more. In interpreting differences between the two groups this has to be taken into account.

In the Class II, division 1 group before treatment, the overbite was complete. In 12 cases the upper and lower incisors were in contact, while in the other 19 cases the lower incisors were in contact with the palate. The reason for selecting cases with a complete overbite was in order to keep abnormalities of tongue to lower lip contact, in posture and behaviour, to a minimum. According to the records there were no finger- or thumb-sucking habits.

Treatment was undertaken to produce the patient's optimal incisal relationship within the limits set by the individual's skeletal and soft tissue morphology. In all the selected cases, this meant a reduction in overbite and overjet. The appliances used varied from patient to patient but two subdivisions were made to study the effects of bite plates and bands. In one sub-group of 12 cases the overbite was reduced essentially by means of an anterior bite plate on which the lower incisors impinged, thus taking the posterior teeth out of occlusion. In the other sub-group of 11 cases the overbite was reduced

Table I.—Mean Values derived from the Tracings of the Radiographs of the Class II, Division I Group

		Class II, Division 1 Group	First Radiograph	Second Radiograph	Third Radiograph	Overall Period	During Active Treatment	After Active Treatment
			11 years 8 months	14 years 2 months	17 years 6 months	5 years 10 months	2 years 6 months	3 years 4 months
Intermaxillary Space	Distances	Molar region				5·3 mm.	3·8 mm.	1·5 mm.
		Incisor region				4·9 mm.	3·9 mm.	1·0 mm.
		Upper first molar	20·4 mm.	22·4 mm.	23·9 mm.	3·5 mm.	2·0 mm.	1·5 mm.
		Lower first molar	26·9 mm.	29·6 mm.	30·5 mm.	3·6 mm.	2·7 mm.	0·9 mm.
		Upper central incisor	26·9 mm.	28·8 mm.	29·6 mm.	2·7 mm.	1·9 mm.	0·8 mm.
		Lower central incisor	39·8 mm.	40·2 mm.	41·7 mm.	1·9 mm.	0·4 mm.	1·5 mm.
		Overbite	7·3 mm.	4·4 mm.	5·4 mm.	−1·9 mm.	−2·9 mm.	1·0 mm.
	Angles	Maxillary-mandibular-planes	25·4°	25·6°	24·6°	−0·8°	0·2°	−1·0°
		Upper central incisor	121·2°	104·7°	108·5°	−12·7°	−16·5°	3·8°
		Lower central incisor	93·4°	99·5°	99·6°	6·2°	6·1°	0·1°
		Inter-incisal	60·2°	50·0°	52·8°	−7·4°	−10·2°	2·8°

essentially by using a fixed appliance of the multiband type placing a depressing force on the incisor teeth.

The structures traced from each radiograph are shown in *Fig.* 1, these are the same as those traced by Parker (1963). A glossary of terms can be found in that article and the distances and angles will now only be listed and not defined.

Distances Measured (*Figs.* 1, 2)

UM–D	Upper molar height.
LM–F	Lower molar height.
UI–C	Upper incisor height.
LI–E	Lower incisor height.
LI–O	Overbite.
F–F^1	Change in height in the molar region.
E–E^1	Change in height in the incisor region.

The first five measurements on the list were made on each tracing (*Fig.* 1). The last two measurements were made after superimposing tracings on the upper part of the palatal shadow and the maxillary plane (*Fig.* 2). In the random group the tracings of the first and second radiographs were superimposed to give the growth change in the molar and incisor regions. In the Class II, division 1 group three radiographs were taken, the tracings were superimposed to give the changes in the height of the molar and incisor regions during the three periods studied. The tracing of the third radiograph was superimposed on the first radiograph to give the overall changes. The tracing of the second radiograph was superimposed on the first radiograph to give the changes during active treatment; finally the third tracing was superimposed on the second to give the changes after active treatment.

Angles Measured (*Fig.* 1)

(ANS–PNS)–(GO–T)	Maxillary-mandibular-planes angle (Mx-Md).
UI–X–PNS	Upper incisor angle (1–Mx).
LI–Y–GO	Lower incisor angle (1–Md).
UI–K–LI	Inter-incisal angle $\frac{(1)}{1}$.

The distances were measured in millimetres and the measurements were made to 0·5 mm. The angles were measured to 0·5°.

FINDINGS

The data collected from the tracings of each child in the Class II, division 1 group were recorded in a table similar to *Table I.* In the random group the recordings were made in a

Table II.—Mean Values, plus Standard Deviations for the Angles, derived from the Tracings of the Radiographs of the Random Group

		Random Group	First Radiograph	Second Radiograph	Average Growth Period
			10 years	14 years 7 months	4 years 7 months
Intermaxillary Space	Distances	Molar region			4·4 mm.
		Incisor region			3·8 mm.
		Upper first molar	19·4 mm.	22·6 mm.	3·2 mm.
		Lower first molar	26·4 mm.	29·0 mm.	2·6 mm.
		Upper central incisor	27·3 mm.	28·9 mm.	1·6 mm.
		Lower central incisor	37·6 mm.	40·4 mm.	2·8 mm.
		Overbite	4·3 mm.	4·1 mm.	−0·2 mm.
	Angles	Maxillary-mandibular-planes	29·0° ±4·0°	27·7° ±4·3°	−1·3°
		Upper central incisor	109·1° ±6·0°	110·2° ±7·3°	1·1°
		Lower central incisor	90·9° ±6·0°	92·6° ±6·1°	1·7°
		Inter-incisal	49·0° ±9·5°	50·5° ±8·9°	1·5°

table similar to *Table II*. These individual tables were then analysed in different ways and the findings were recorded in tabulated form and then used to prepare illustrations.

Tables I and *II* contain the mean data derived from the tracings of the Class II, division 1 and random groups respectively. In *Table II* the standard deviation for certain angles is also shown. The contents of these tables were used to prepare a series of scale drawings. *Figs.* 3 and 4 were drawn to compare the features of the abnormal intermaxillary space (Class II, division 1 occlusion) (broken line) with the normal for the population (solid line) derived from the random group. *Fig.* 3 shows before treatment of the Class II, division 1 occlusion and *Fig.* 4 is after treatment and out of retention. *Fig.* 5 shows the overall changes in the abnormal intermaxillary space while *Fig.* 6 shows the normal (mean) growth changes in the normal intermaxillary space. In *Figs.* 3, 4, and 5, the intermaxillary spaces were superimposed on the maxillary planes with the axial lines of both upper central incisors intersecting about one-third the way down the roots of these teeth. In *Fig.* 6 the intermaxillary spaces were superimposed on the maxillary planes with the apex of the upper central incisor in the second radiograph (broken line) on the axial line of the upper central incisor in the first radiograph (solid line). The appearance of the drawings was thought to be the same as if the intermaxillary spaces had been superimposed on the maxillary planes and the bony palatal shadows of the maxillae.

A convenient way of expressing the position of the molar and incisor planes is relative to the maxillary and mandibular planes (*Tables III, IV*). The percentage calculations were based on the mean data in *Tables I* and *II*. At each stage in development the sum of the upper and lower molar heights was expressed as 100 per cent (*Table III*). There was a similar calculation with upper and lower incisor heights (*Table IV*).

Table III.—Percentage Analysis to show the Normal Positions of the Molar Plane derived from the Random Group and the Positions in the Class II, Division 1 Group. The Position is Relative to the Maxillary and Mandibular Planes

Groups	Molar Percentage Analysis				
	Class II, Division 1 Group			*Random Group*	
	First Radiograph	Second Radiograph	Third Radiograph	First Radiograph	Second Radiograph
Upper first molar	43	43	44	42	44
Lower first molar	57	57	56	58	56

Table IV.—Percentage Analysis to show the Normal Positions of the Incisor Plane derived from the Random Group and the Positions in the Class II, Division 1 Group. The Position is Relative to the Maxillary and Mandibular Planes

Groups	Incisor Percentage Analysis				
	Class II, Division 1 Group			*Random Group*	
	First Radiograph	Second Radiograph	Third Radiograph	First Radiograph	Second Radiograph
Upper central incisor	40	42	42	42	42
Lower central incisor	60	58	58	58	58

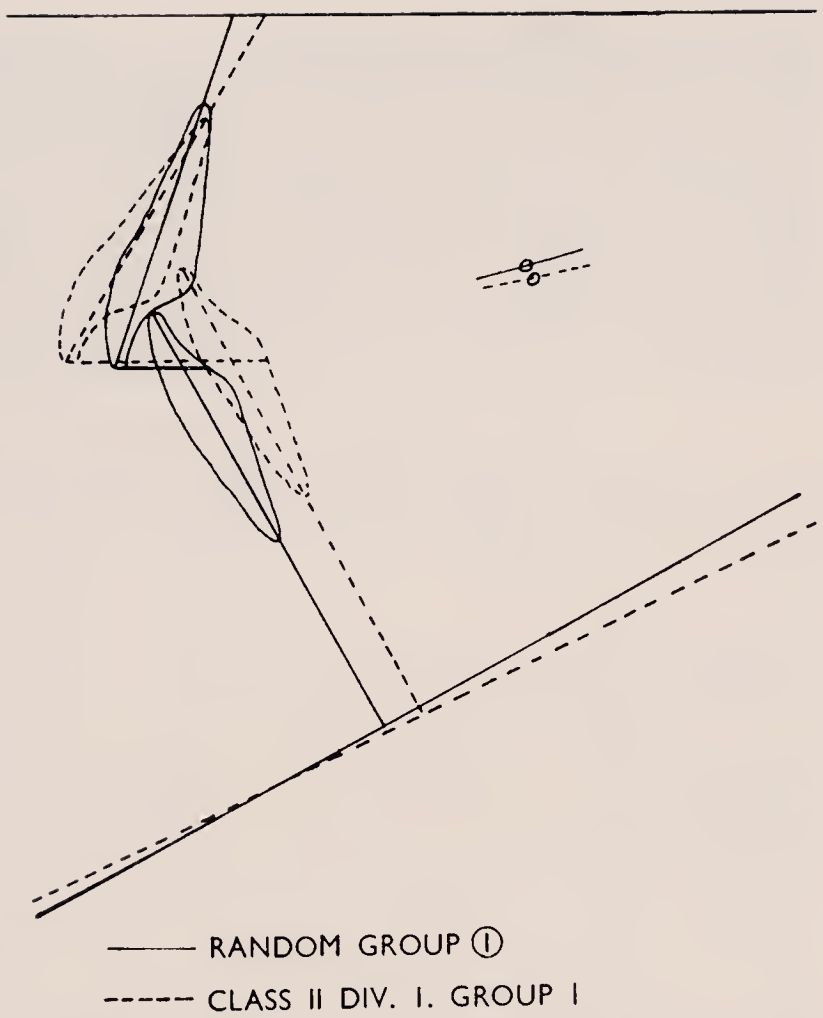

Fig. 3.—Mean intermaxillary space of the Class II, division 1 group before treatment (broken line) superimposed on the normal intermaxillary space (solid line) showing differences in dental base relationship and abnormal development in the incisor region of the Class II, division 1 group.

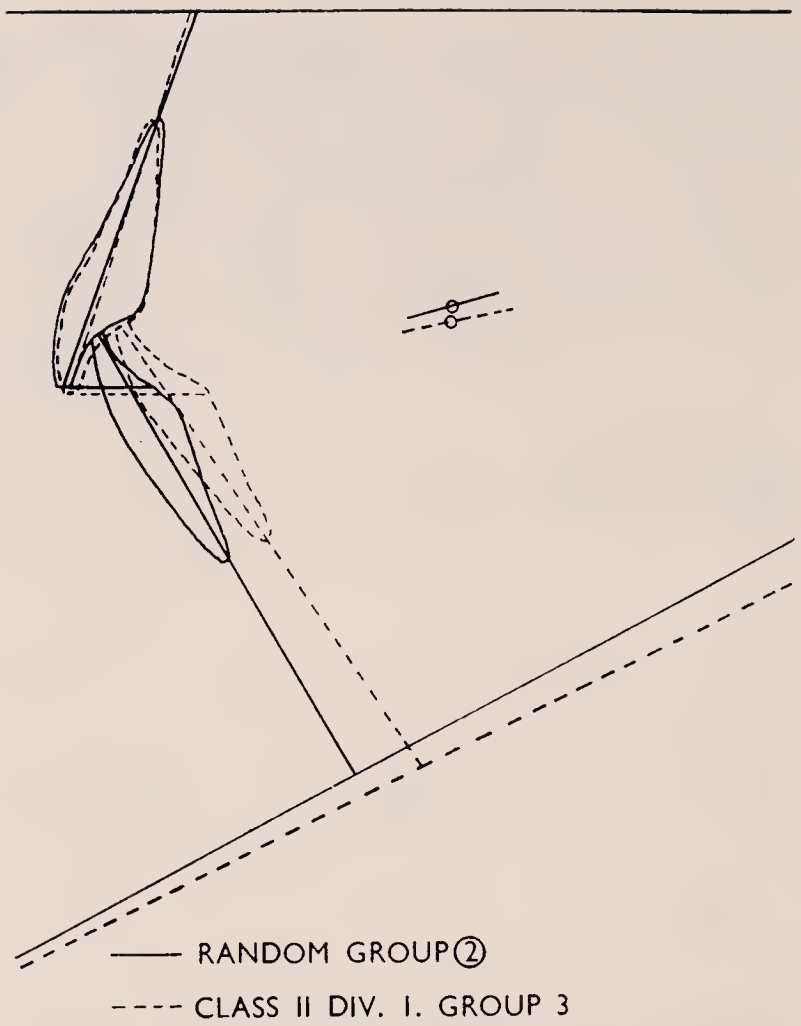

Fig. 4.—Mean intermaxillary space of the Class II, division 1 group out of retention (broken line) superimposed on the normal intermaxillary space (solid line) showing, in spite of the differences in dental base relationship, close similarities in development within the intermaxillary spaces.

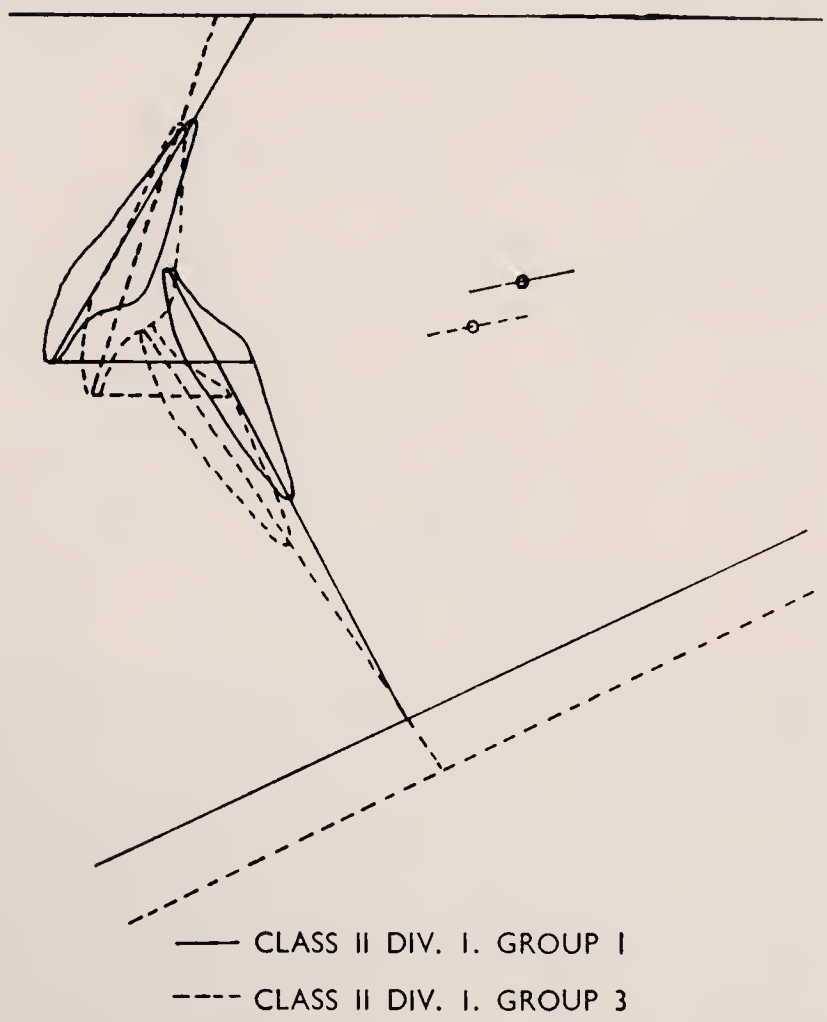

Fig. 5.—Mean intermaxillary spaces of the Class II, division 1, before treatment (solid line) and out of retention (broken line) superimposed to show the overall changes produced by treatment and growth.

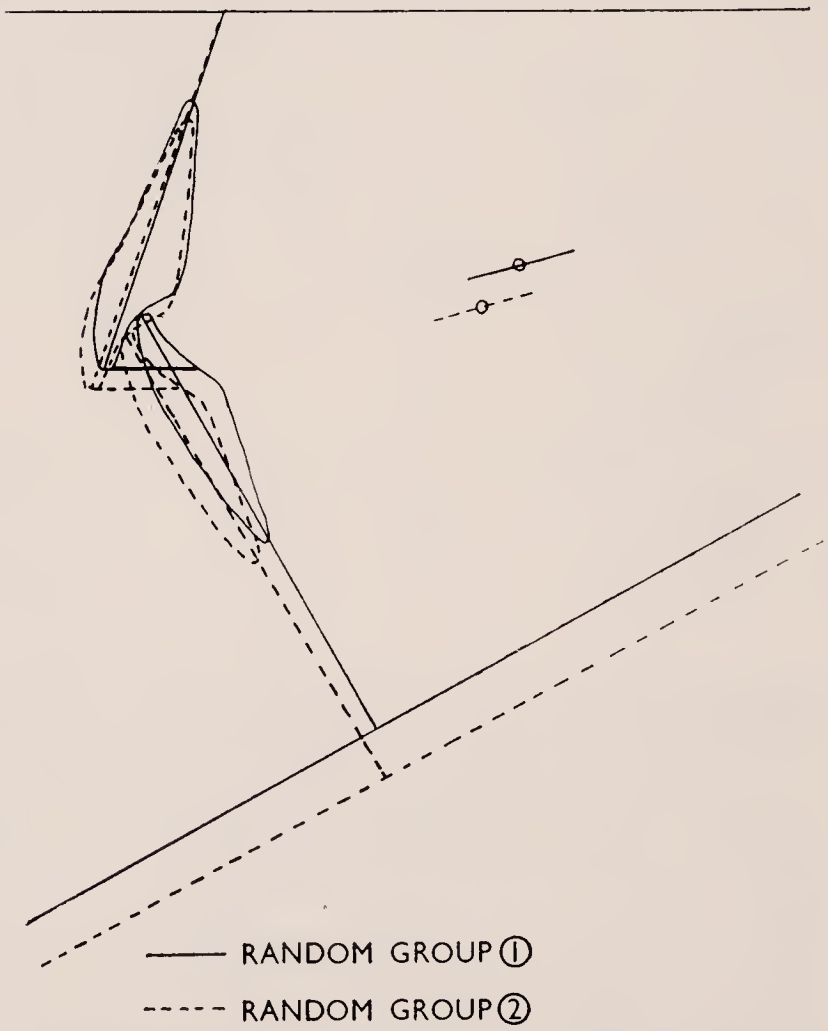

Fig. 6.—Normal intermaxillary spaces derived from the first (solid line) and second (broken line) radiographs of the random group superimposed to show normal growth changes.

The mean values in *Tables I* and *II* were also used to draw a series of graphs (*Figs.* 9–17). Points **1** and **2** represent the mean calculated from the first and second radiographs of the random group (*Table II*) and points **1, 2,** and **3** the mean calculated from the first, second, and third radiographs of the Class II, division 1 group (*Table I*). This visual representation of growth and change could be misleading if certain shortcomings were not recognized. Interpolation of the recorded points indicates an even rate of growth but this is not completely accurate; there is accelerated growth at puberty. However, the two groups match up well with respect to age. Another complication is anteroposterior movement of the teeth within the intermaxillary space. The intermaxillary space is wedge-shaped which means that if its height remains constant and all the teeth occlude then, as the teeth move anteriorly or posteriorly, vertical adjustments in their height must occur—an increase in height if they move anteriorly, a decrease in height if they move posteriorly. The post-normal relation of the molars reduced in the treated group whereas the molar relation was constant in the random group; this meant that differences in the behaviour of the molar heights in the two groups were to be expected. This complication also arose in the incisor region, where in the treated group the upper incisors were moved palatally and the lower incisors moved labially, whereas in the untreated group the angular relations were almost unchanged. Finally, the difference in the skeletal pattern and the progress towards skeletal maturity in the two groups meant that absolute differences were to be expected. In spite of these limitations useful information can be collected, e.g., comparing the abnormal rates of change in the molar heights with the normal gives a valuable indication as to whether at a particular stage the intermaxillary space is vertically stable.

Table V.—The Four Mean Patterns of Vertical Growth of the Intermaxillary Space covering the Three Periods of Observation

Vertical Growth Patterns Class II, Division 1 Group				
Periods of Observation	*Overall Period*	*During Active Treatment*	*After Active Treatment*	
			24 cases. Height of Intermaxillary Space Increasing	4 cases. Height of Intermaxillary Space Decreasing
	11 years 8 months to 17 years 6 months	11 years 8 months to 14 years 2 months	14 years 2 months to 17 years 6 months	
Molar region	1·0	1·0	1·0	−1·0
Incisor region	0·9	1·1	0·6	−2·0
Upper first molar	0·7	0·6	1·0	1·3
Lower first molar	0·7	0·7	0·8	−1·6
Upper central incisor	0·5	0·5	0·7	−1·0
Lower central incisor	0·3	−0·3	1·2	−0·3
Overbite	−0·4	−0·9	0·9	0·8

A similar series of graphs was prepared to study the mean changes in the maxillary-mandibular-planes angle, overbite, lower and upper incisor heights in the two sub-groups treated with different appliances (*Figs.* 18–21). *Figs.* 18–21 also include a table showing the individual variation in response to bite plates and bands found during active treatment.

Another way of detecting abnormal changes in the intermaxillary space is by comparing vertical patterns of growth. This method of analysis was described by Parker (1963) and the pattern is based on a 1 mm. change in height of the molar region. This form of analysis is valuable where the group studied contains individuals of different ages with varying amounts of growth. The soundness of the method depends on the fact that the individual's facial growth pattern has a high degree of stability and is little affected by age (Brodie, 1953). *Table VI* contains the mean vertical pattern of growth for the random group

along with the standard deviation. *Fig.* 8 is a histogram drawn from this data. There were two difficulties in calculating the mean patterns for the Class II, division 1 occlusions. The first was the 3 cases where no pattern could be calculated because the molar region did not change in height (*Table VII*). The other difficulty was the antero-posterior movement of teeth since this resulted in changes in their height to maintain the level of occlusion. This was very marked in two cases and these were discarded when the mean was calculated. *Table V* contains the mean pattern for the Class II, division 1 group during the three periods of observation and *Fig.* 7 is a histogram drawn from this data. In *Fig.* 7 each of the seven distances measured is represented by a series of four lines. The first and heaviest of the four lines depicts the mean for the overall period, the second shows active treatment, while the third and fourth cover the period after active treatment. The third line represents the cases where the molar region increased in height and the fourth where the molar region decreased in height. Negative values indicate decrease in height.

Table VI.—The Normal Pattern of Vertical Growth of the Intermaxillary Space, plus Standard Deviation derived from the Random Group

Vertical Growth Patterns Random Group	
Average Growth Period	10 years to 14 years 7 months
Molar region	1·0
Incisor region	0·9 ±0·15
Upper first molar	0·8 ±0·24
Lower first molar	0·6 ±0·31
Upper central incisor	0·4 ±0·30
Lower central incisor	0·7 ±0·27
Overbite	0·0 ±0·48

Besides a comprehensive analysis of the mean changes the individual variation was also recorded and studied. *Table VII* gives the individual variation found during the three periods of observation in the Class II, division 1 group. During each period studied the distance or angle measured may increase, decrease, or remain unchanged. A similar table was also prepared for the random group (*Table VIII*).

DISCUSSION

A. A Comparison of the Intermaxillary Spaces of the Two Groups

The children presenting with Class II, division 1 occlusions had their intermaxillary spaces compared with the normal (mean) intermaxillary spaces (derived from the untreated random group) on two occasions. The first (*Fig.* 3) was before treatment and the second (*Fig.* 4) was after the occlusion had settled following treatment.

The first of these comparisons was based on the first radiographs of both groups. Parker (1963) discussed the findings in detail and the following are the main points. There was only a slight difference in the vertical relation of the dental bases as judged by the mean maxillary-mandibular (Mx-Md)-planes angle (*Tables I, II*). The mean angle in the Class II, division 1 group was slightly smaller and this was associated with a greater degree of post-normality in the dental base relationship (*Fig.* 3). Within the mean intermaxillary spaces it was thought that if a correction was applied for the differences in age and growth, the relative position of the molar plane was similar in both groups (*Table III*). The position of the incisor plane was nearer to the maxillary plane in the Class II, division 1 group than normal. There was an associated upper incisor proclination with the lower incisors more vertically placed than in the random group, (*Table IV; Fig.* 3). The differences in the position of the incisor plane could not be explained on grounds of differences in age and growth.

To summarize, the mean shapes of the intermaxillary spaces, and therefore the relationship of the dental bases, were different in the two groups. The mean development of the dento-alveolar structures was abnormal in the incisor region but normal in the molar region. These findings suggest that the soft tissues were an aetiological factor in the occlusal abnormality, the other factor being the abnormal dental base relationship.

In the second comparison based on the final radiographs of the two groups it was again found that the mean maxillary-mandibular-planes angles were slightly different (*Tables I, II; Fig.* 4). The difference was slightly less than before treatment. Within the mean intermaxillary spaces the relative position of the molar planes was the same in both groups (*Table III*). The mean incisor relationship in both groups was Class I and the relative position of the incisor planes was the same (*Table IV*). The differences in the angulations of the incisor teeth and in the amount of overbite were thought to be the result

of difference in the anteroposterior relations of the dental bases in the two groups. The Class I incisor relation in the treated group was thought to represent the optimal relationship within the limits set by the skeletal and soft tissue morphology.

To summarize, the mean differences in dental base relationship were virtually unchanged. The

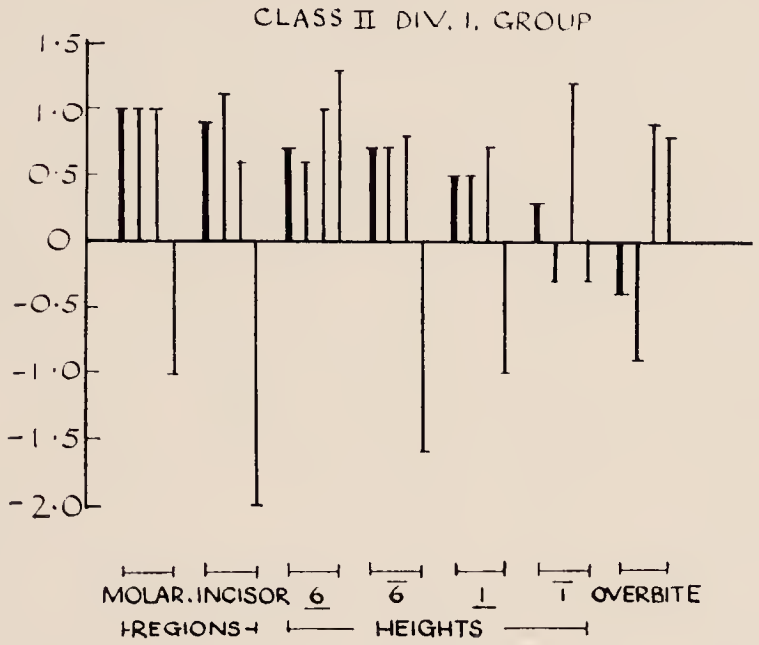

Fig. 7.—Histogram from data in *Table V*; this shows four mean patterns of vertical growth of the intermaxillary space in the Class II, division 1 group. Reading from left to right, these are:—1. Overall pattern (heaviest line); 2. Pattern during active treatment; 3. Pattern after active treatment (height of intermaxillary space increased); 4. Pattern after active treatment (height of intermaxillary space decreased).

mean development of the dento-alveolar structures was still normal in the molar region and now almost normal in the incisor region. The fact that the change in the abnormal (Class II, division 1) intermaxillary space was localized to the incisor region points to a change in the influence of a local factor which was thought to be the soft tissues. The differences still present in the incisor region were attributed to differences in dental base relationship. These findings also clarify the objectives of treatment, which, in general, should be the repositioning of the upper and lower incisors with no attempt to change the relationship of the dental bases or level of occlusion in the molar region (Parker, 1963).

The changes which occurred between the first and last radiographs in the two groups should now be discussed and comparisons made between the abnormal changes and the growth changes observed in the untreated random group.

B. Overall Changes in the Treated Group and the Growth Changes in the Untreated Group

Before commenting on the overall changes in the Class II, division 1 group the growth changes in the random group will be described. A detailed description of the growth changes in the random group was given by Parker (1963) of which the following is a summary. The normal (mean) growth change was a slight alteration in the shape of the intermaxillary space as it increased in height; there was a small decrease in the maxillary-mandibular-planes angle. Within the intermaxillary space there was a relative descent of the molar plane, but not the incisor

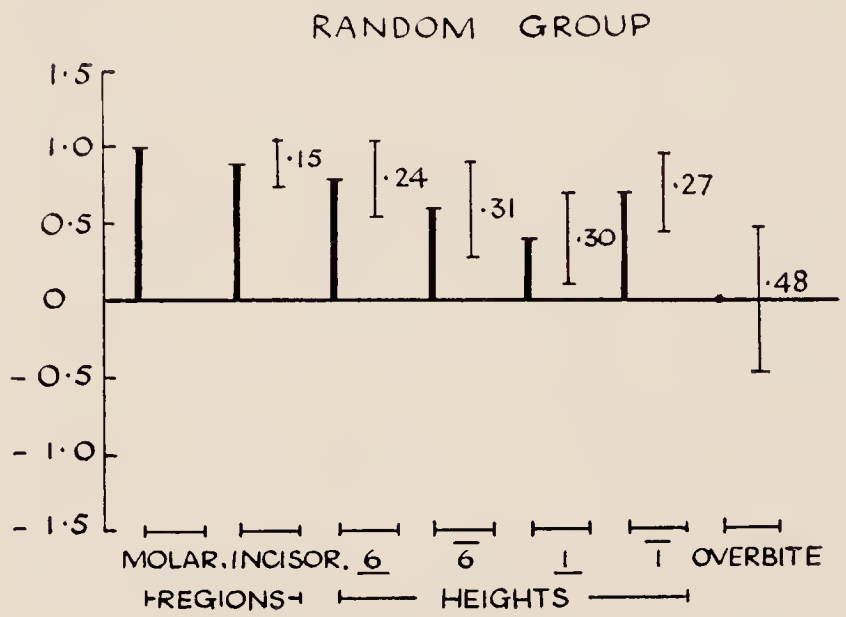

Fig. 8.—Histogram from data in *Table VI;* this shows the mean and standard deviation for the pattern of vertical growth of the intermaxillary space in the random group.

plane. With respect to the angular relations of the incisors the group characteristics were little changed during the growth period but individuals within the group changed within certain limits. *Fig.* 6 shows the normal (mean) growth changes.

The mean overall changes in the Class II, division 1 group showed the normal growth trend of alteration in the shape of the intermaxillary space as it increased in height (*Fig.* 5). The decrease in the maxillary-mandibular-planes angle in the treated group was slightly less than the normal growth trend. This small difference could indicate that in the treated group the intermaxillary space had not quite fully reverted to its original pattern of growth. Within the mean intermaxillary space of the treated group there was a slight relative descent of the molar plane which was similar to the normal growth trend (*Table III*). However, there were differences in the anteroposterior movement of the molar teeth in the two groups. The normal growth tendency was for the molar relationship to remain constant whereas in the Class II, division 1 group the molar relationship on average became less post-normal. This resulted in the upper molar height increasing less than the normal and the lower molar height more than the normal (*Tables V, VI; Figs.* 7, 8). In spite of these small differences the vertical pattern of growth of the molar region was essentially the same in both groups. The incisor region provided the striking differences between the two groups (*Figs.* 5, 6). The normal vertical

pattern of growth showed a constant overbite with the lower incisor developing vertically more than the upper incisor (*Table VI; Fig.* 8). This contrasted with the treated group where there was overbite reduction, this being accompanied with less than normal lower incisor vertical development and more than normal upper incisor vertical development. (*Table V; Fig.* 7). Overbite reduction occurred primarily as the result of reducing the vertical development of the lower incisors, the reason the molar region was not thought to play a part was the similar behaviour of the mean maxillary-mandibular-planes angle in the two groups. The greater vertical development of the upper incisors in the treated group caused the relative descent of the incisor plane which did not occur in the random group (*Table IV*). There were differences in the angular behaviour of the incisor teeth in the two groups (*Tables I* and *II*). This was not very marked in the lower incisors; 6° proclination in the treated group as opposed to 1° proclination in the random group. The retraction of the upper incisors changed their relation to the lower lip and allowed them to develop vertically.

To summarize, the mean overall changes in the treated Class II, division 1 group was a slight alteration in the shape of the intermaxillary space as its height increased. The relative position of the molar and incisor planes descended with a marked change in the relationship of the incisors. The only marked difference between these changes and the normal growth changes was in the incisor region. These findings indicate that, in the long term, treatment has only influenced the pattern of development of the dento-alveolar structures in the incisor region. This was the region where development of the dento-alveolar structures was abnormal before treatment.

Mention will now be made of the individual variations found (*Tables VII, VIII*). Cases of decrease in the height of the teeth measured occurred in the Class II, division 1 group but not the random group. The reason for the depression of these teeth was thought to be their altered anteroposterior position in the wedge-shaped intermaxillary space. This is another piece of evidence to support the concept that the height of the teeth is secondary to the height of the intermaxillary space. Previously the work of Thompson and Brodie (1942), Thompson (1946) and Tallgren (1957) has established the fact that the growth of the intermaxillary space is co-ordinated with facial and general skeletal growth and is not dependent on the eruption of the teeth.

C. Changes during and after Treatment in the Class II, division 1 Group

The overall changes in the treated group were a combination of the changes during treatment and those after treatment.

Changes during Treatment

The intermaxillary space slightly changed its shape as it increased in height with a slight increase in the mean maxillary-mandibular-planes angle (*Table I*); this is the reverse of the normal growth trend where the maxillary-mandibular-planes angle decreased (*Table II*). The explanation was thought to be the excessive rate of vertical development of the upper and lower molars compared with the normal (*Figs.* 9, 10). This resulted in a slight increase in the mean maxillary-mandibular-planes angle (*Fig.* 11) which was thought to indicate an excessively high intermaxillary space for the developmental stage. There was further evidence to support the view that the intermaxillary space was vertically unstable in the individual behaviour of the maxillary-mandibular-planes angle; 12 cases of increase during treatment (*Table VII*) compared to 2 cases in the random group (*Table VIII*). The excessive vertical growth in the molar region which 'propped open' the bite on the molar teeth caused a reduction in the overbite. Besides this excessive rate of increase in the height of the molar region the vertical pattern of growth was also abnormal (*Table V; Fig.* 7). The lower molar height increased more than the upper molar height which was the reverse of the normal growth pattern (*Table VI; Fig.* 8). Part of this could be explained on the differing amount of antero-posterior movement of the teeth in the two groups; this mechanism was described in the section on the overall changes. However, a similar reversal of the normal growth pattern was observed by Sleichter (1954) in non-extraction cases treated with bite plates. This abnormal pattern of growth resulted on average in the relative position of the molar plane remaining unchanged in the treated group while it descended in the random group (*Table III*). The change in the incisor relationship during treatment was from Class II, division 1 to Class I. This resulted from a retraction of the upper incisors which, on average, were retroclined 17° while the lower incisors proclined 6°. This retraction of the upper incisors changed their relation to the lower lip and allowed them to develop vertically. As a result, on average, the incisor plane descended and took up the same relative position as that in the random group (*Table IV*). This descent of the incisor plane contrasts with the normal where the relative position of the incisor plane was unchanged. The abnormal vertical pattern of growth in the incisor region showed a greater increase in upper incisor height compared to lower incisor height (*Table V; Fig.* 7); this was a reversal of the normal growth pattern (*Table VI; Fig.* 8). The reduced vertical development and even depression (*Table VII*) of the lower incisors, corrected or even over-corrected the excessive vertical development that the abnormally related

Table VII.—The Individual Variation found in the Treated Class II, Division 1 Group during the Three Periods of Observation

	Class II, Division I Group	Overall Period			During Active Treatment			After Active Treatment		
		Number of Cases			Number of Cases			Number of Cases		
	Type of Change	+	0	−	+	0	−	+	0	−
Intermaxillary Space — Distances	Molar Region	31	0	0	29	2	0	26	1	4
	Incisor region	30	0	1	29	2	0	21	4	6
	Upper first molar	29	0	2	24	4	3	23	8	0
	Lower first molar	29	1	1	30	1	0	19	7	5
	Upper central incisor	29	1	1	27	1	3	21	7	3
	Lower central incisor	25	3	3	19	4	8	26	3	2
	Overbite	3	4	24	0	2	29	21	4	6
Intermaxillary Space — Angles	Maxillary-mandibular-planes	12	5	14	12	7	12	5	11	15
	Upper central incisor	1	0	30	0	1	30	24	3	4
	Lower central incisor	26	0	5	26	1	4	15	7	9
	Inter-incisal	9	0	22	6	2	23	22	2	7

Table VIII.—The Individual Variation found in the Untreated Random Group during Growth

	Random Group	Average Growth Period 10 Years to 14 Years 7 Months		
		Number of Cases		
	Type of Change	Increase +	No change 0	Decrease −
Intermaxillary Space — Distances	Molar region	33	0	0
	Incisor region	33	0	0
	Upper first molar	33	0	0
	Lower first molar	30	3	0
	Upper central incisor	31	2	0
	Lower central incisor	32	1	0
	Overbite	12	3	18
Intermaxillary Space — Angles	Maxillary-mandibular-planes	2	11	20
	Upper central incisor	18	6	9
	Lower central incisor	20	5	9
	Inter-incisal	20	2	11

incisors had allowed. This behaviour of the lower incisors combined with the excessive vertical growth in the molar region was responsible for the overbite reduction which occurred during active treatment.

To summarize, the excessive and abnormal vertical growth in the molar region resulted in an unstable vertical height for the intermaxillary space and a failure on average of the relative position of the molar plane to descend. The excessive growth in the molar region also caused a reduction in the overbite. The overbite was also reduced in the correction of the abnormally related incisors by the reduced vertical development of the lower incisors. The retraction of the upper incisors changed their relation to the lower lip which allowed them to develop vertically with a descent of the incisor plane. These findings differ markedly from the normal growth changes and the long term changes in this treated group. The short term changes brought about by treatment were considerably more extensive than those in the long term. In the long term, treatment only produced an abnormal pattern of development in the incisor region, but in the short term treatment produced an abnormal pattern of growth in the molar and incisor regions which in turn influenced the vertical relationship of the dental bases.

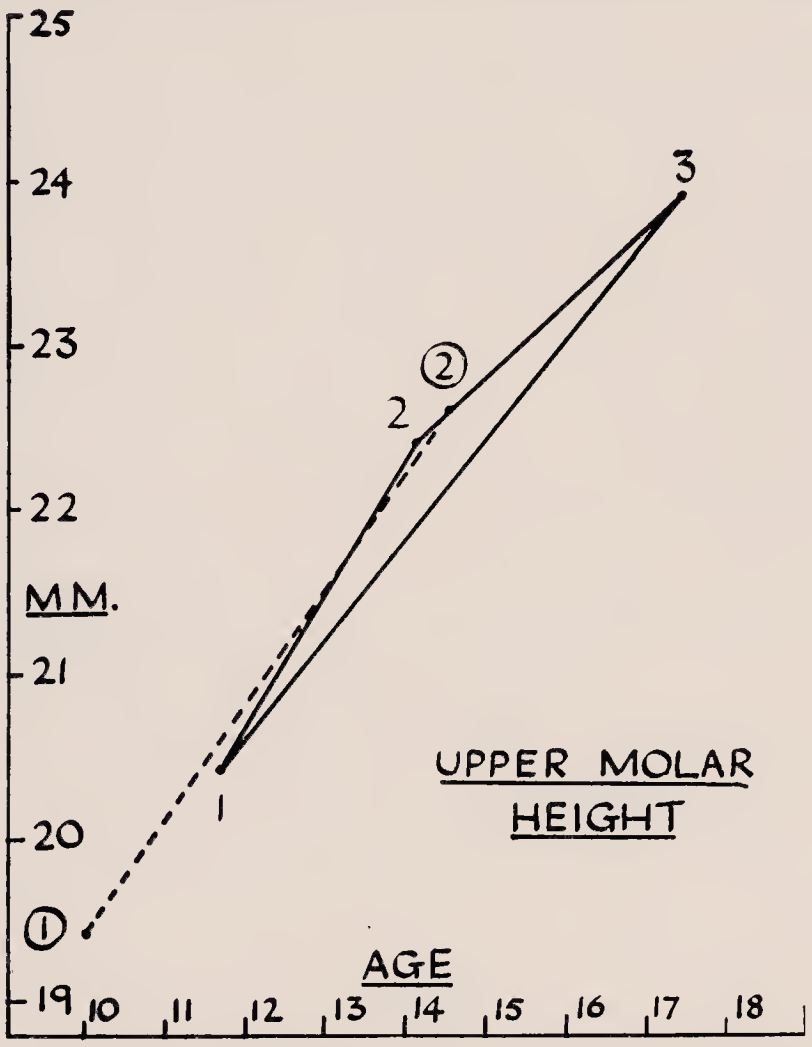

Fig. 9.—Graph of the upper molar height from data in *Tables I, II*, showing the normal (broken line) and abnormal (solid line) rates of change. 1–2: normal rate derived from the random group. In the Class II, division 1 group, 1–3: overall rate, 1–2: rate during active treatment, 2–3: rate after active treatment.

Changes after Treatment

After active treatment most patients wore retainers for a variable period of time before the occlusion was allowed to settle. In most cases the height of the intermaxillary space increased but there were 4 cases where it decreased (*Table VII*). These 4 cases where the normal growth process was reversed were strong evidence to support the view that the height of the intermaxillary space was excessive at the end of active treatment. The mean intermaxillary space changed its shape as it increased in height, with a decrease in the maxillary-mandibular-planes angle (*Table I*); this was similar to the normal growth trend (*Table II; Fig.* 11). The mean decrease in the maxillary-mandibular-planes angle in the treated group was thought to be a combination of the growth process recontouring the gonial angle and the reduced rate of increase of both the upper and lower molar heights compared with the rate during treatment and the normal (*Figs.* 9, 10). This behaviour of the upper and lower molar heights was taken as evidence of a reversion to a stable vertical height for the intermaxillary space. This reduced rate of vertical growth in the molar region was also one of the factors tending to increase the overbite. Two mean vertical patterns

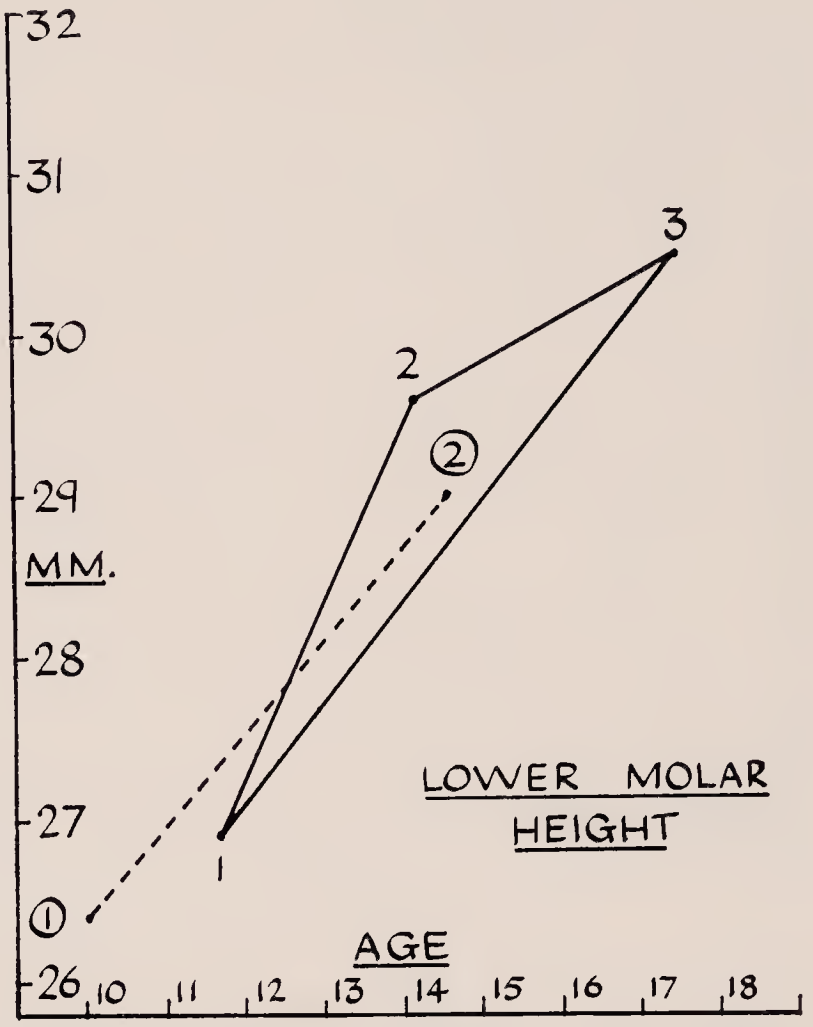

Fig. 10.—Graph of the lower molar height from the data in *Tables I, II*, showing the normal (broken line) and abnormal (solid lines) rates of change. 1–2: normal rate derived from the random group. In the Class II, division 1 group, 1–3: overall rate, 1–2: rate during active treatment, 2–3 rate after active treatment.

of growth were calculated for the period after treatment. The first was derived from the 26 cases of increase in the height of the intermaxillary space while the second was derived from the 4 cases of decrease in height (*Table V; Fig.* 7). The first mean pattern showed the upper molar

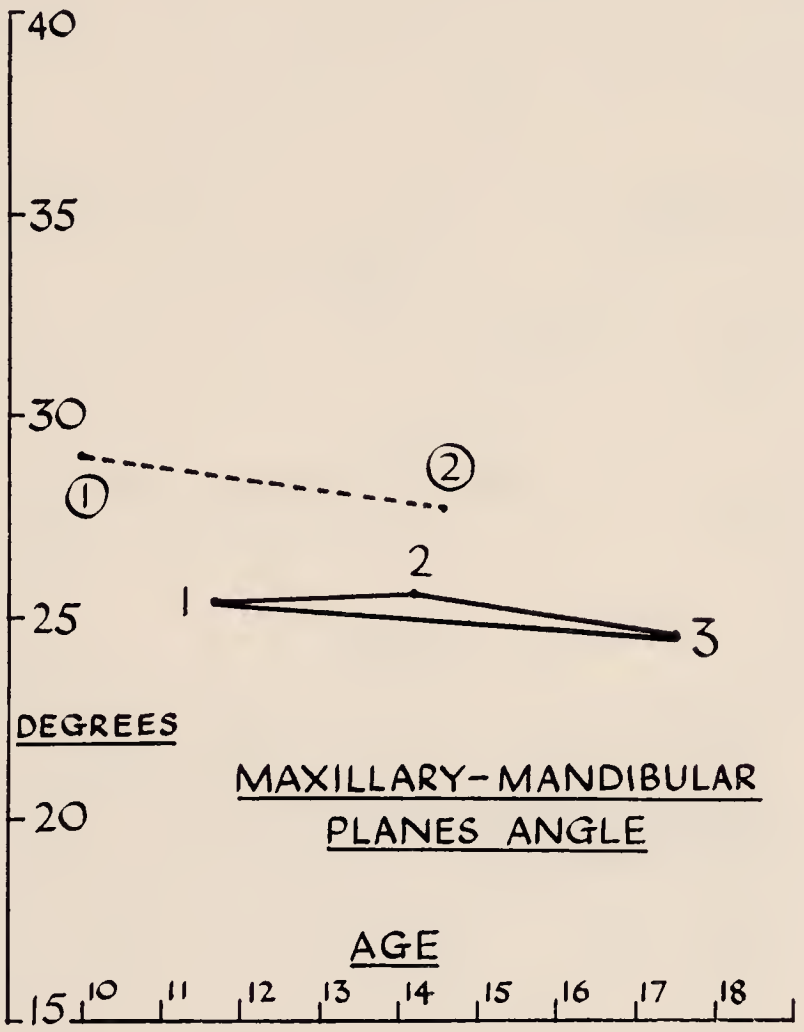

Fig. 11.—Graph of the maxillary-mandibular-planes angle from the data in *Tables I, II*, showing the normal (broken line) and abnormal (solid lines) rates of change. 1–2: normal rate derived from the random group. In the Class II, division 1 group, 1–3: overall rate, 1–2: rate during active treatment, 2–3: rate after active treatment.

incisors moved labially a fraction with an average 4° proclination (*Fig.* 12) while the average angulation of the lower incisors was unchanged (*Fig.* 13). The result was a slight mean increase in the inter-incisal angle (*Fig.* 14). The positions of the upper and lower incisors on average were

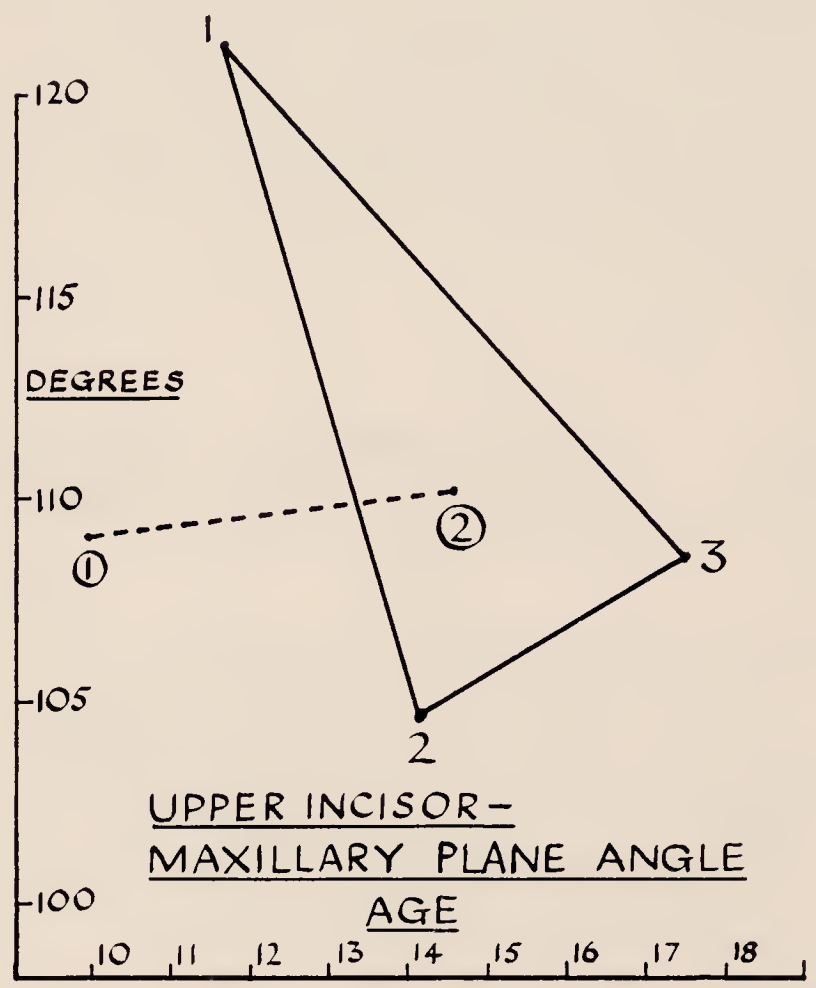

Fig. 12.—Graph of the upper incisor angle from the data in *Tables I, II*, showing the normal (broken line) and abnormal (solid lines) rates of change. 1–2: normal rate derived from the random group. In the Class II, division 1 group, 1–3: overall rate, 1–2: rate during active treatment, 2–3: rate after active treatment.

height to increase more than the lower molar height (*Table V; Fig.* 7), which is similar to the normal growth pattern (*Table VI; Fig.* 8). The second pattern showed that although the height of the intermaxillary space decreased the height of the upper molar teeth increased while the lower molars were depressed (*Table V; Fig.* 7). Both these patterns were thought to be in the nature of a correction for the abnormal pattern which occurred during treatment where the lower molar height increased more than the upper molar height. The patterns of growth established in the molar region after treatment resulted on average in a relative descent of the molar plane which at the end of the observation period was in a similar position in both the treated and random group (*Table III*). These findings were strong evidence for the view that the level of the molar plane is genetically controlled. In the incisor region the incisal relationships changed relatively little after treatment. On average the upper virtually in labio-lingual balance at the end of active treatment. The relative position of the incisor plane after treatment was unchanged on average and so continued to occupy the same relative level as that found in the normal intermaxillary space (*Table IV*). After treatment the average overbite increased (*Fig.* 15) which was expected. Backlund (1958) investigated cases with complete overbites and found that the amount of overbite was dependent on the angular relation of the incisor teeth and the shape of the palatal surfaces of the upper incisors. Applying this to the Class II, division 1 group, it meant that because of the greater than normal dental base post-normality and inter-incisal angle, a greater than normal vertical development of the lower incisors would occur before an incisor contact was achieved. *Fig.* 15 shows that this in fact occurred; it was thought that part of the increase in the overbite was due to the closure of the maxillary-mandibular-planes angle, and part

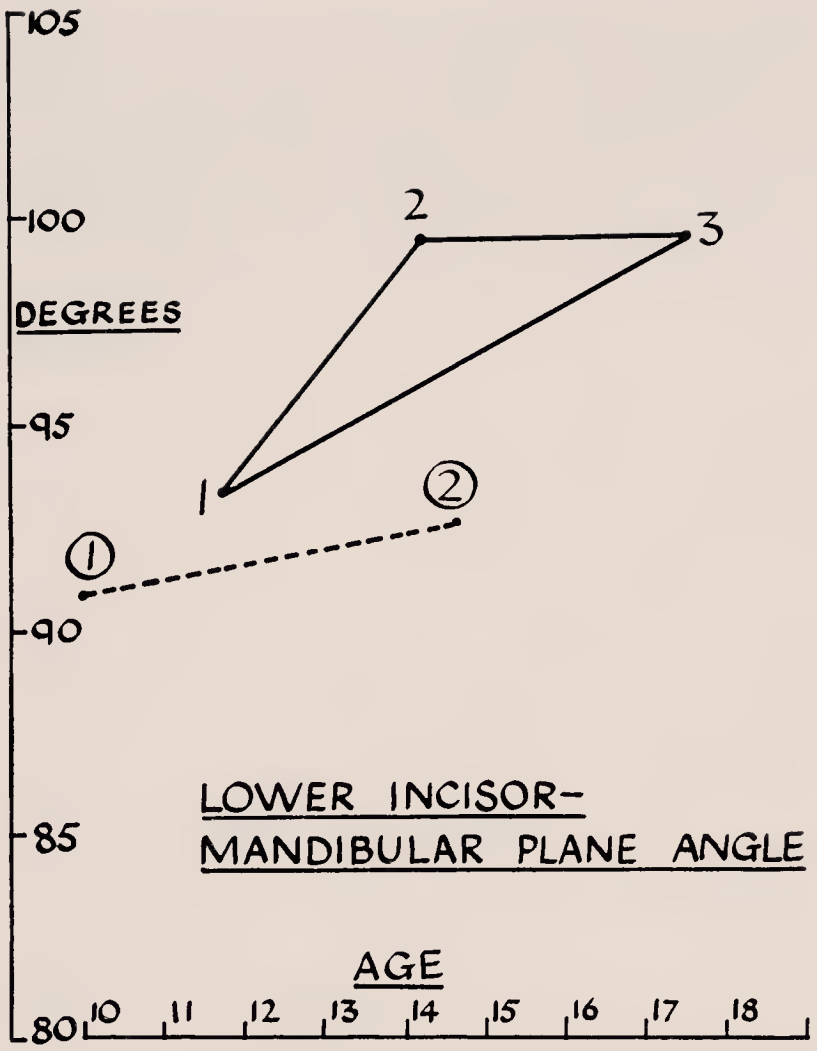

Fig. 13.—Graph of the lower incisor angle from the data in *Tables I, II*, showing the normal (broken line) and abnormal (solid lines) rates of change. 1–2: normal rate derived from the random group. In the Class II, division 1 group, 1–3: overall rate, 1–2: rate during active treatment, 2–3: rate after active treatment.

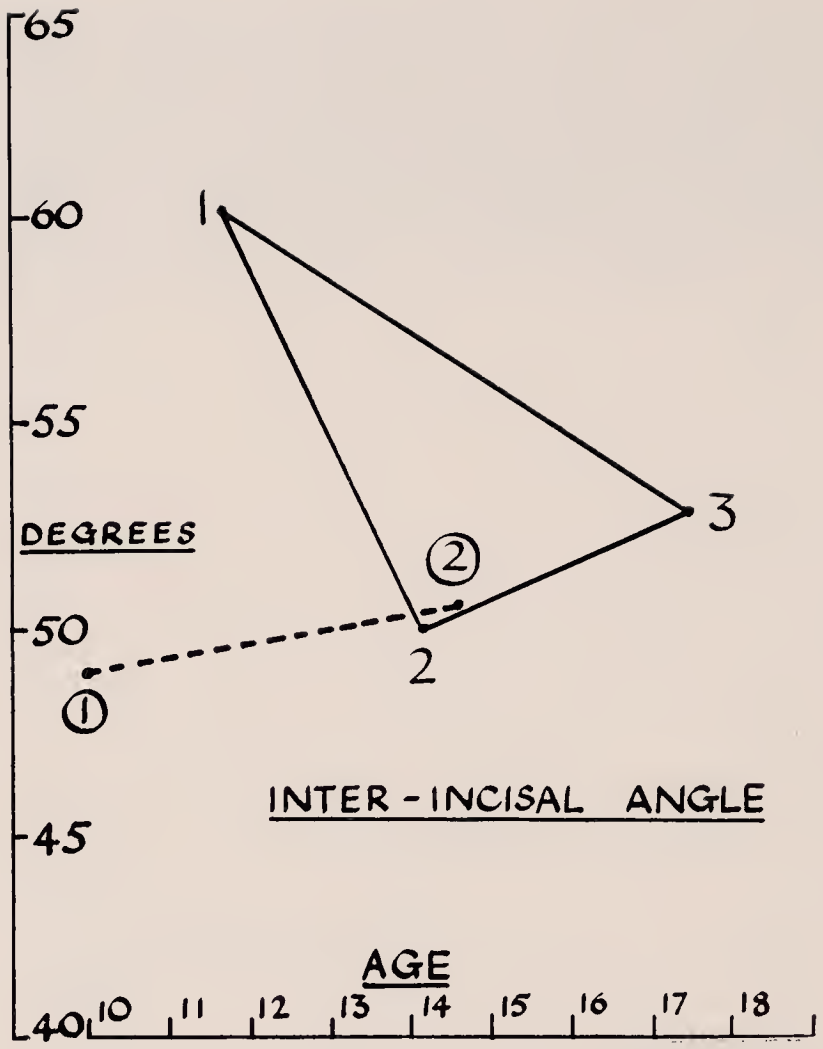

Fig. 14.—Graph of the inter-incisal angle from the data in *Tables I, II*, showing the normal (broken line) and abnormal (solid lines) rates of change. 1–2: normal rate derived from the random group. In the Class II, division 1 group, 1–3: overall rate, 1–2: rate during active treatment, 2–3 rate after active treatment.

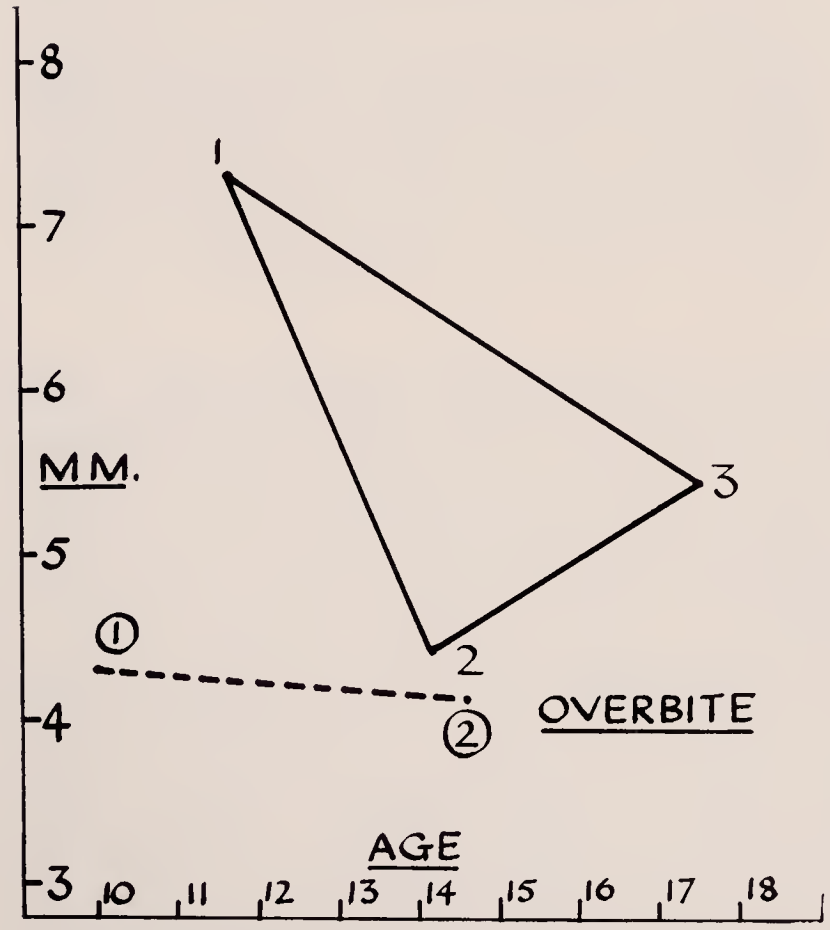

Fig. 15.—Graph of the overbite from the data in *Tables I, II*, showing the normal (broken line) and abnormal (solid lines) rates of change. 1–2: normal rate derived from the random group. In the Class II, division 1 group, 1–3: overall rate, 1–2: rate during active treatment. 2–3: rate after active treatment.

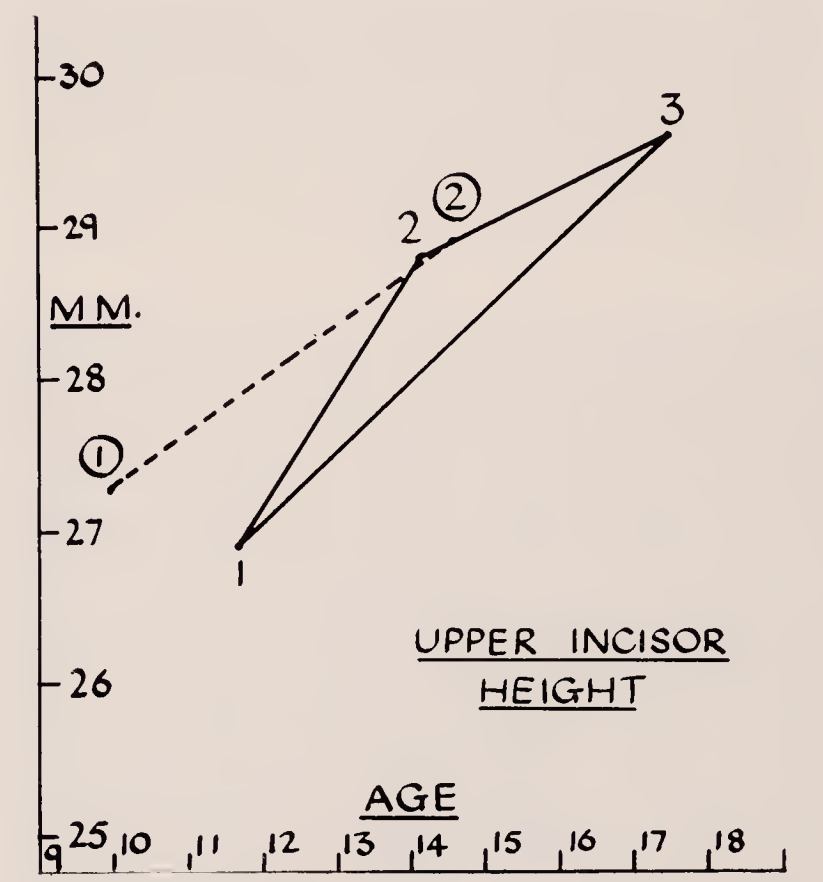

Fig. 16.—Graph of the upper incisor height from the data in *Tables I, II*, showing the normal (broken line) and abnormal (solid lines) rates of change. 1–2: normal rate derived from the random group. In the Class II, division 1 group, 1–3: overall rate, 1–2: rate during active treatment, 2–3: rate after active treatment.

resulted from the greater increase in lower incisor height compared with the upper (*Table V; Fig.* 7). The influence of these two factors varies from case to case, depending on the excessive height of the intermaxillary space, but on average the rate of upper and lower incisor vertical development

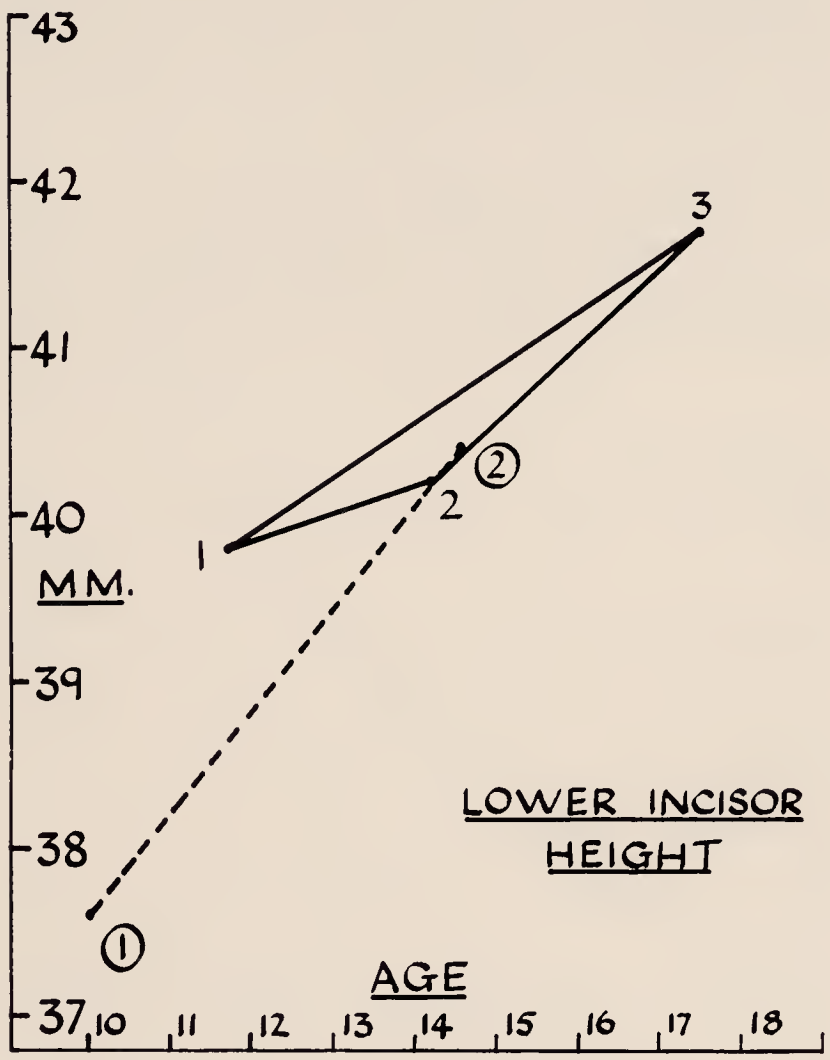

Fig. 17.—Graph of the lower incisor height from the data in *Tables I, II*, showing the normal (broken line) and abnormal (solid lines) rates of change. 1–2: normal rate derived from the random group. In the Class II, division 1 group, 1–3: overall rate, 1–2: rate during active treatment, 2–3: rate after active treatment.

is still less than normal (*Figs.* 16, 17). The influence of closure of the maxillary-mandibular-planes angle can be so marked that it can cause depression of the upper and lower incisors. This occurred in the 4 cases where the height of the intermaxillary space decreased (*Table V; Fig.* 7).

To summarize, there was a variation in the behaviour of the height of the intermaxillary space, most cases increased but a few decreased. The shape of the mean intermaxillary space changed with a mean closure of the maxillary-mandibular-planes angle; this was partly due to the reduced rate of growth in the molar region. The relative position of the molar plane descended on average and in a few cases there was depression of the lower molars. On average there was little change in the incisal relationship other than an increase in overbite. These findings indicate that in the long term, treatment can only produce limited changes in the original pattern of growth due to the genetic control of the growth process. There is a mechanism for re-establishing the original pattern of growth which did not operate on the incisal relationship due to a change in the influence of the soft tissues on the incisor teeth.

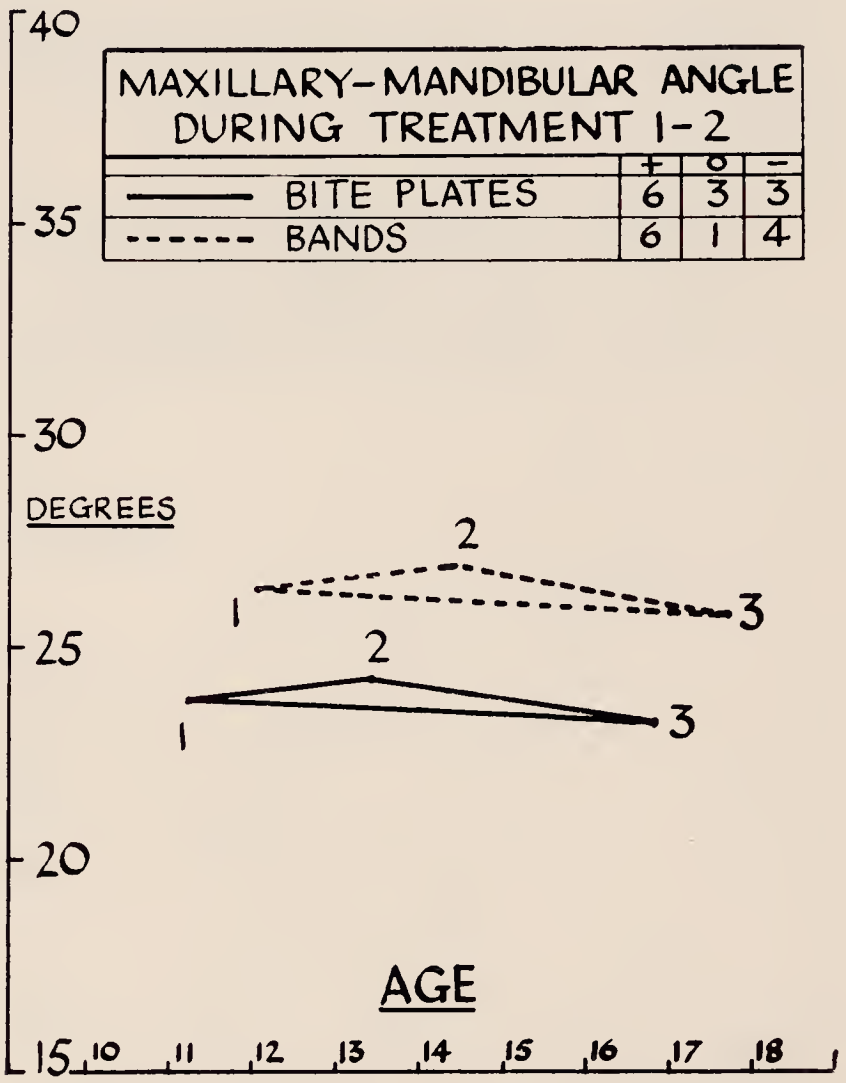

Fig. 18.—Graph of the maxillary-mandibular-planes angle showing the mean rate of change in the sub-group wearing bite plates (solid line) and the sub-group wearing multiband appliances (broken line). In both sub-groups 1–3: overall rate, 1–2: rate during active treatment, 2–3: rate after active treatment. The table shows the individual variation in response to treatment found in the two sub-groups.

D. The Effects of Bite Plates and Multiband Appliances

Within the Class II, division 1 group there were 12 children treated essentially with an anterior bite plate and 11 children treated with a fixed appliance of the multiband type; these two sub-groups were studied separately. The other 8 children were treated with a combination of these appliances and it is not proposed to study these.

Graphs were prepared from the mean values calculated for the two sub-groups to show the behaviour of the maxillary-mandibular-planes angle (*Fig.* 18), overbite (*Fig.* 19), lower incisor height (*Fig.* 20), upper incisor height (*Fig.* 21). *Figs.* 18–21 also contain tables which show the individual variation found in the recorded angle or distance during the period of active treatment. These measurements could increase, remain unchanged, or decrease.

From the earlier discussion it would appear that overbite reduction during treatment occurs in two ways: (i) Excessive vertical development of the upper and lower molars, particularly the lower, for the developmental stage. (ii) Reduced vertical development and even depression of the lower incisors.

It is now proposed to analyse the effects of the two different appliances to find out how they work.

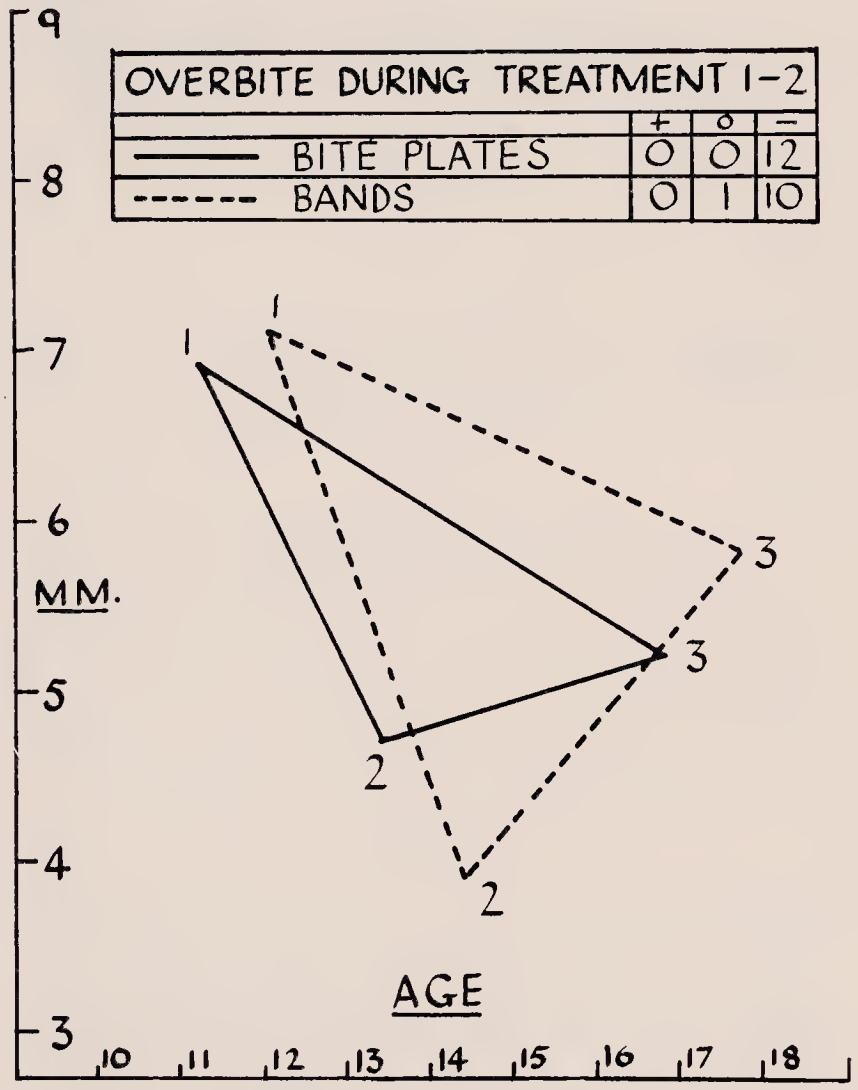

Fig. 19.—Graph of the overbite showing the mean rate of change in the sub-group wearing bite plates (solid line) and the sub-group wearing multiband appliances (broken line). In both sub-groups 1–3: overall rate, 1–2: rate during active treatment, 2–3: rate after active treatment. The table shows the individual variation in response to treatment found in the two sub-groups.

In both the sub-groups there was an increase in the mean maxillary-mandibular-planes angle during treatment with little difference in individual behaviour (*Fig.* 18). Compared with the normal there was excessive vertical development of the upper and lower molars which was of a similar amount in both sub-groups. It would therefore appear that this factor caused a similar amount of overbite reduction in both sub-groups. However, *Fig.* 19 shows a greater reduction of overbite during treatment with the multiband appliance. These differences must arise from the incisor region because of the similar behaviour of the molar regions in the two sub-groups. However, before these are considered it should be pointed out that this greater reduction in overbite in the banded sub-groups was not on average maintained (*Fig.* 19). The explanation was thought to be due to differences in the morphological features of the two sub-groups which were present before treatment.

In the incisor region a striking difference was found in the behaviour of the lower incisors (*Fig.* 20). The mean trend during active treatment in the sub-group wearing bite plates was for the

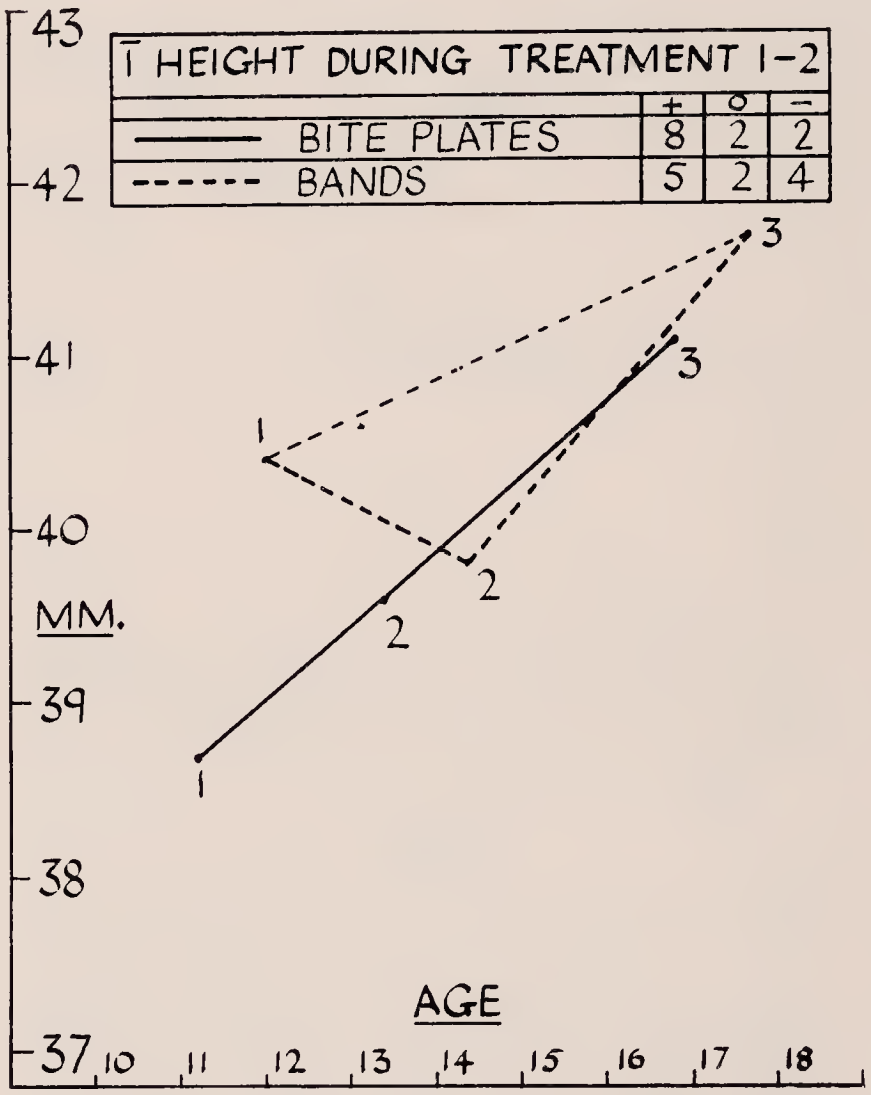

Fig. 20.—Graph of the lower incisor height showing the mean rate of change in the sub-group wearing bite plates (solid line) and the sub-group wearing multiband appliances (broken line). In both sub-groups 1–3: overall rate, 1–2: rate during active treatment, 2–3: rate after active treatment. The table shows the individual variation in response to treatment found in the two sub-groups.

lower incisor height to increase whereas this decreased in the sub-group wearing bands. Broadway (1958) reported similar findings. However, there were 2 cases where the lower incisors were depressed and 2 cases where they failed to develop vertically in the sub-group wearing bite plates. Cases of decrease were more numerous with those wearing bands; however, the mean does tend to be distorted because of one case where the lower incisors were depressed 7 mm. In both sub-groups the lower incisors were proclined on average about the same amount during active treatment. After appliances were discarded there was only a 1° change on average in the angulation of the lower incisors in both sub-groups.

The behaviour of the upper incisor height during active treatment, on average, was similar in the two sub-groups (*Fig.* 21). However, there was a considerable difference in the change of angulation in these teeth which should be taken into account. In the children wearing bite plates the incisors were retroclined on average from 122° to 110° whereas in the sub-group with bands the figures were 120° to 99°. The average labial relapse after treatment was 3° in the former sub-group and 5° in the latter. It would, therefore, appear that the bands were more effective in controlling the vertical growth of the upper incisors compared with the bite plates. This is based on the assumption that there was a similar pivotal point for rotation of the upper incisors during retraction in both sub-groups.

Additional support for this view was found in the individual behaviour of the upper incisors (*Table VII*), all 3 cases where these teeth were depressed wore a banded appliance on the upper incisors.

Because of the variations in the morphological features of patients with Class II, division 1 occlusions, different appliances were necessary to place the teeth into a position where it was possible for the individual to complete the change to his optimal pattern of development. The similarity of the mean angular changes in the two sub-groups after treatment indicates that the success in judging the individual in relation to his optimal pattern of development was about the same using bite plates or bands.

To summarize, the main difference in the two forms of appliances would appear to be in their influence on the incisors rather than the molar teeth. In the banded cases it was thought that the increased vertical development of the molars was the reaction to the depressing forces on the incisors whereas in the cases with bite plates this resulted from the molar teeth being out of occlusion when the incisors struck the bite plate. Although the causes for the changes were different, the effects were similar, but of varying degree. The differences in the behaviour of the incisors was quite marked, the bands being undoubtedly more effective in controlling the vertical development of the incisors. The use of bands is, therefore, more appropriate in the treatment of patients with severe incisor malrelation.

SUMMARY

A group of 31 children who received orthodontic treatment to change their Class II, division 1 occlusions into Class I occlusions had lateral skull radiographs taken before treatment, after active treatment, and out of retention. The intermaxillary space was traced from each radiograph, these were then measured and analysed and compared with a second group of 33 children selected at random. The random group which did not receive orthodontic treatment had lateral skull radiographs taken at two different ages in order to establish the features of the normal (mean) intermaxillary space for the population and the individual variation found. The normal growth changes and individual variation for the age span were also assessed.

This study was based on the comparative features and behaviour of the intermaxillary spaces in the two groups of children described above. The dento-alveolar structures in the Class II, division 1 occlusion were only abnormal in the incisor region, the abnormality was due to the combined influences of the soft tissues and the abnormal dental base relationship. The overall effects of treatment were virtually limited to changes in the dento-alveolar structures in the abnormal incisor region. Treatment achieved an improvement in the incisal relationship which was stable because of a change in the influence of the soft tissues on the incisor teeth. The improved incisal relationship was still slightly abnormal; this was due to the influence of the abnormal dental base relationship. During

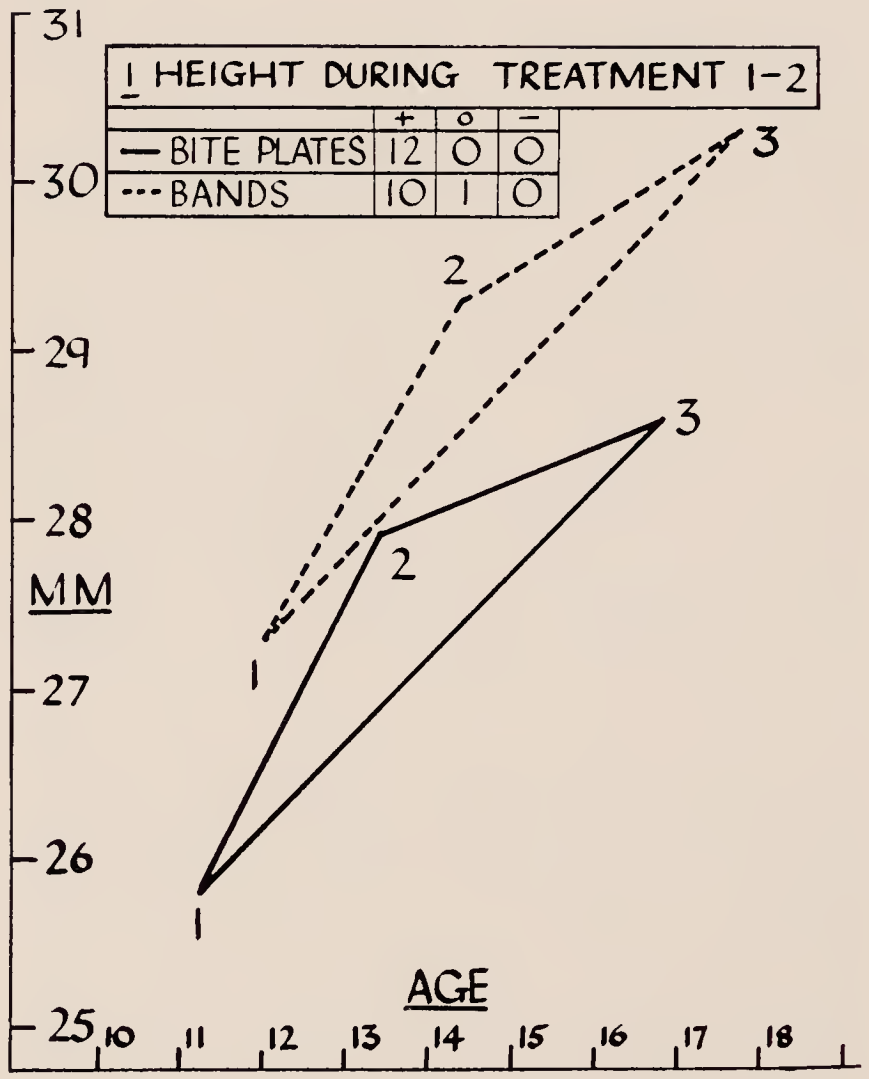

Fig. 21.—Graph of the upper incisor height showing the mean rate of change in the sub-group wearing bite plates (solid line) and the sub-group wearing multiband appliances (broken line). In both sub-groups 1–3: overall rate, 1–2: rate during active treatment, 2–3: rate after active treatment. The table shows the individual variation in response to treatment found in the two sub-groups.

treatment widespread changes occurred in the intermaxillary space, these affected the molar and incisor regions and the vertical relationship of the dental bases. The changes after treatment were in the nature of a reversion to the original pattern of development. These findings suggest a genetic control to the growth process which extends to the control of the development of the dento-alveolar structures as well as dental base relationship. This control means that treatment can only produce limited permanent changes and these can be anticipated before treatment. The individual variation in the type and amount of movement of the incisor teeth required to achieve the optimal incisal relationship has resulted in the use of different appliances. Two of these, bite plates and multiband appliances, were compared and the main differences were their effects on the incisors rather than the molars. The bands were undoubtedly more effective in controlling the vertical development of the incisors, which means that this appliance is more appropriate in the treatment of patients with severe incisor mal-relation.

Finally an attempt was made in *Table IX* to show the relation of the treated individuals to their optimal pattern of development.

Acknowledgements

I would like to thank Professor C. F. Ballard for his permission to report on these children who attended the Eastman Dental Hospital, London. I am also indebted to Miss S. B. Magarshack for her patience in tracing the lateral skull radiographs.

Table IX.—The Relation of the Treated Individuals to their Optimal Pattern of Development

Stages	Intermaxillary Space; Height of Space	Molar Plane	Incisor Plane	Incisor Relationship
Before treatment	Correct	Correct	Incorrect. Too high	Class II, Division 1 Not optimal
End of active treatment	Incorrect. Unstable due to excessive height	Incorrect. Too high	Almost correct	Class I almost optimal
End of observation	Correct	Correct	Correct	Class I optimal

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DISCUSSION

Mr. J. H. Gardiner, opening the discussion, said that, in the early part of his paper, Mr. Parker gave the impression that the anomaly in increased overbite cases was confined to the incisor region. Later in the paper, he mentioned that in treatment there was an excessive vertical development of the upper and lower molars, and secondly, some depression of the lower incisors. In his final summary, he confirmed that the only changes were in the incisor regions. Could he give further information to answer these seeming contradictions?

As Mr. Parker said, his samples of children—31 and 33—were small but were doubtless limited by the time factor. Did he have plans to extend these numbers?

On the question of the accuracy of cephalometric tracings, had Mr. Parker checked the radiographs by comparison with random repeat exposures taken by a different radiographer and did he check the accuracy of the tracings with several repeat tractings by different tracers? It was naturally difficult to predict growth changes, so would it not have helped if a third group, of Class II malocclusions, had without any treatment been kept under observation for a similar period?

During the treatment of the Class II group, a proclination of 6° in the lower incisors was recorded. In the case of the 12 children treated with anterior bite plates, were these of the Sved-type with partial capping of the upper incisors? If of the non-Sved

type, was the bite plane sloping or flat? If the latter, what was the explanation of the forward tilting of the lower incisors?

Mrs. E. G. Lindon asked whether the age group of the Class II, division 1 group was near the average or whether there was scatter. Was the skeletal pattern taken into account for either of the groups, and was the facial morphology taken into account at all? She also wondered whether one could actually take the tracings to 0·5°.

Mr. F. Allan wondered whether, to decrease the anterior overbite, the posterior teeth developed further vertically. If so, did they eventually return to their original height, and what then happened to the lower incisor level? How much of the decreased incisor overbite was due to depressed lower incisors, and how much to vertical movement of the posterior teeth? If both were a temporary phase, would the lower incisors be further depressed when normal centric relation was re-established?

Mr. A. J. Walpole Day said that he was fascinated by the final position of the upper incisor teeth after treatment of the Class II, division 1 cases. The angle of the incisors was so near to the normal that it seemed incredible. He found that there were two kinds of Class II, division 1 cases: those in which the maxilla seemed to be rather prominent and those in which the mandible seemed to be rather small. One explanation for this result in angulation of the upper incisor would be that the cases treated were those with prominent maxillae, in which some people extracted the upper first premolar and retracted the incisor teeth. In other cases, where the mandible was small and the teeth were extracted in the upper, they appeared to be retroclined, in a Class II, division 2 position, when treatment was finished. One would expect that, on the lateral radiograph of the average treated case, the angle of the upper incisors would be retroclined compared with the random sample.

Mr. C. P. Briggs said that Mr. Parker, in describing his landmarks at the beginning, had described the point T. Was this in fact Menton, or a new point which Mr. Parker found more suitable?

Mr. D. M. Menezes said that most of Mr. Parker's patients came to the Eastman Dental Hospital for orthodontic treatment. From where did he get the control group? He himself had great difficulty in finding random groups and often had to resort to school clinics.

Obviously, when carrying out such a detailed line of treatment there must have been cases when the first permanent molars had had to be extracted through caries. How did this affect Mr. Parker's results?

Mr. B. S. Cryer asked whether, in view of the similarity of the end-results produced in the two groups—those treated with bands and those treated with bite plates—the more difficult technique of using a lower fixed appliance as part of the treatment was felt to be fully justified in these cases?

Mr. A. Shotts asked how many cases of each sort Mr. Parker had started with, which did not finish the treatment?

Mr. H. Lester asked Mr. Parker by what criterion he judged the amount that the anterior bite plate was thickened, and if, in fact, this was just done, as most people did, empirically?

Mr. Parker, in reply, said that the improvement which occurred in the incisor region was the result of changes in both the molar and incisor regions during treatment. While the improvement in the incisor region was maintained the changes in the molar region disappeared as the child continued to grow. He agreed that the samples were small and that it would have been an advantage to have had a Class II, division 1 group which did not have any orthodontic treatment but such a group was not available.

With regard to the accuracy of radiographs, again he agreed with Mr. Gardiner. Although the radiographs had not been repeated, the tracings had, both by the same tracer and by himself.

He thought that the proclination of 6° could have occurred in a variety of ways. He thought part of this was due to the use of Class II intermaxillary traction which was used both in cases treated by banded appliances and removable appliances. Another factor was the change in the position of the tongue during treatment, this also may have proclined the lower incisors. Yet another possibility was the forward component of force which resulted from an inclined tooth striking a horizontal bite plate. It was thought that an inclined bite plane would tend to cause even more proclination of the lower incisors. None of the patients had a Sved bite plate.

Fortunately, the scatter in the ages of both the Class II, division 1 group and in the random group was similar. He had a scatter diagram to establish this point. With regard to assessment of skeletal pattern from the tracings, this could be determined by Professor Ballard's method of correcting the angulation of the incisor teeth to normal values. The morphology of the soft tissues of each patient had been recorded in the hospital documents.

In reply to Mr. Allan, as to whether incisor teeth would remain depressed, he thought he had shown this to be so, fairly conclusively. Originally as the incisors developed from the abnormally related dental bases they failed to establish contact. The upper incisor development was prematurely arrested on the lower lip whereas the lower incisors developed an excessive amount until they usually contacted the palate. Treatment depressed the lower incisors and retracted the upper incisors into contact with the lower incisors. Because the incisors were now in contact only a small amount of vertical development of the lower incisors was possible before their development was arrested on the cingula of the upper incisors.

There were differences in the angulation of the incisor teeth in the random group and the treated group at the end of the observation period. There was a higher inter-incisal angle in the treated group which was chiefly responsible for the greater overbite in this group.

With regard to Mr. Briggs' question on cephalometric landmarks the point T was Menton.

In reply to Mr. Menezes, the Children's Department of the Eastman Dental Hospital had an arrangement by which they provided dental care for certain local schools. Nearly every child attended the hospital and in certain age-groups lateral skull radiographs were taken and it was these which constituted the random group. With regard to the second point there were very few extractions in the random group, only 6 children in the random group had extractions during the period studied, with a total of 11 teeth removed.

In reply to Mr. Cryer as to whether the multiband appliance was really necessary, he thought it was. He thought that one had to get to a point with treatment

where the person could change to his optimal pattern of development. In the Class II, division 1 type of incisal relation the patient changed the way in which he produced an anterior oral seal. In certain cases it was critical that the height of the intermaxillary space and also that of the teeth should not be too great at the end of treatment otherwise the new type of anterior oral seal could not be maintained.

This was really an extended study of cases who had completed treatment. He was therefore not in a position to comment on how many patients had failed to complete treatment.

Mr. Lester had asked about thickening of bite plates. These bite plates were incorporated into the original appliances and as far as he was aware none of them had been thickened subsequently.

ORAL MUSCULAR BEHAVIOUR

K. P. LIDDELOW, F.D.S. R.C.S., H.D.D. (Edin.)

Professor of Prosthetic Dentistry, King's College Hospital Dental School

WHEN I was a student I was taught to look at prosthetics mainly from a mechanical viewpoint. Dentures were set up with the back teeth on the ridge and the front teeth set somewhat forward of the ridge to support the lips and with the minimum overbite and overjet in order to satisfy what were considered to be the mechanical requirements of stability. Dentures with teeth set in this manner tended to produce an Angle's Class I type of occlusion for all individuals and markedly reduced the tongue space posteriorly. Many patients with teeth set as described managed admirably, but a hard core existed, and still exists today, who cannot manage their dentures.

Failure of dentures stems from a wide variety of reasons. One reason, and this is the one I want to consider here, is failure to design the dentures so that the outline of the periphery, the shape of the polished surfaces, and the position of the teeth fits in with the muscular activity of the structures which invest the dentures.

These structures are the tongue, the lips, cheeks, and corners of the mouth. Sir Wilfred Fish drew attention in 1933 to the importance of shaping the dentures in relation to the activity of the enveloping musculature, but many of the lessons which he taught have not been learned, even today. I have recently been investigating the effect of the surrounding muscles on artificial dentures by means of slow-motion cinematography. This paper was based primarily on slow-motion films shown at the meeting at which this paper was read, although, of course, it is not possible to reproduce them here.

THE ACTIVITY OF THE TONGUE

A series of films taken to show the activity of the tongue in patients, some of whom controlled their dentures well and some of whom were incapable of controlling them, enables one to draw these tentative conclusions:—

1. However well retained the dentures may be initially, sooner or later the patient has to learn control of the dentures by means of his tongue.

2. The tongue controls the lower denture by rising above and forcibly pushing it downwards and forwards.

3. The tongue controls the upper dentures by pushing upwards on an area distant from the displacing load which is being applied.

4. The action of the tongue in chewing is to receive the food and to hold it in a slight hollow on its anterior two-thirds and then, turning through an acute angle, to throw the food between the teeth of the chewing side. During this action the posterolateral surface of the tongue sweeps forcefully upwards and outwards against the posterior lingual aspect of the lower denture.

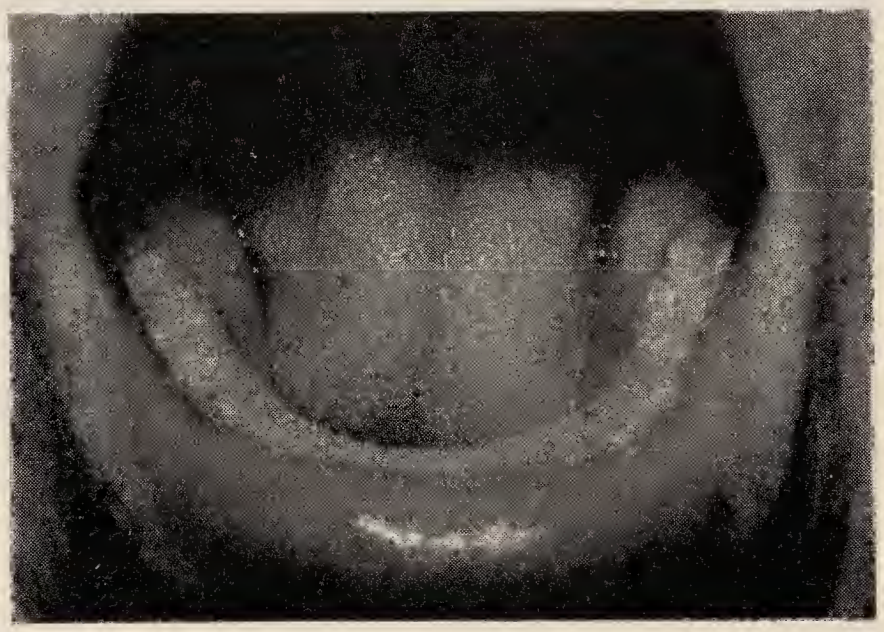


Fig. 1.—Defensive tongue.

From these points the following conclusions may be drawn concerning the design of dentures:—

1. The occlusal plane of the lower denture should be kept as low as other considerations, such as the interalveolar distance and the appearance of the patient, will allow, so that the tongue may easily rest on the denture.

2. The lower denture should be wide in the region of the first and second molar teeth, and, in no circumstances, should these teeth overhang the tongue or the patient will be quite unable to prevent the denture rising at the back as the tongue sweeps up when placing the food between the teeth.

From an examination of film taken of those patients who were unable to control their dentures satisfactorily, the main difference appeared to be that, instead of the tongue rising well above the lower denture and pressing against both upper and lower dentures, it retreated under the denture and assumed a position well back in the mouth. I have termed this type of tongue the ' defensive ' tongue (*Fig.* 1), because it appears

Presented at the meeting held on 9 March, 1964.

more concerned with protecting the pharynx against the dentures than helping to stabilize them. If the dentures are held firmly in place the position of the tongue will alter, accept the presence of the dentures, and assume a more normal posture in the mouth. This is well shown by a patient who had inadequate tongue control until the dentures were held in the correct position by physical forces. A cinematographic film of the patient five years later showed that the dentures had by that time become quite loose, but that the patient had developed tongue control.

Fig. 2.—Alginate showing forward slope of Angle Class I type of lip activity.

THE ACTIVITY OF THE LIPS

The type of lip activity has a very important bearing on the position of the anterior teeth of artificial dentures. Dentures may be unstable because the anterior teeth have been set too far forwards so that each time the individual opens the mouth or separates his teeth in chewing the lower denture rises off the ridge. I have examined such cases with cinematographic film and wish to consider two of them, one being Class II, division 2, and the other Class II, division 1 with a tongue-thrust. In both instances these individuals had been provided with dentures with the anterior teeth set to simulate an Angle Class I jaw relationship. When the dentures were re-made with the anterior teeth set to conform to the powerful activity of the lower lip and the tongue-thrust, these dentures remained stable in function. In my experience, it is frequently the individual with the Angle's Class II jaw relationship who produces problems of denture stability, for the teeth are often set to simulate an Angle's Class I jaw relationship. This is most common when a normal skeletal base exists. Moreover, individuals with an Angle's Class II jaw relationship sometimes have the vertical dimension increased when recording the jaw relationship because some practitioners fail to appreciate that the jaw separation in many Class II cases is so much less than in individuals with Class I jaw relationship.

The problem arises of diagnosing an Angle's Class II jaw relationship, especially with a normal skeletal base, if the patient has never been seen prior to the extraction of the natural teeth. The solution lies in observing lip activity of these individuals in function because it is primarily the lip activity during chewing which determines the position of the artificial teeth if the dentures

Fig. 3.—Alginate showing backward slope of Angle Class II, division 2, lip activity.

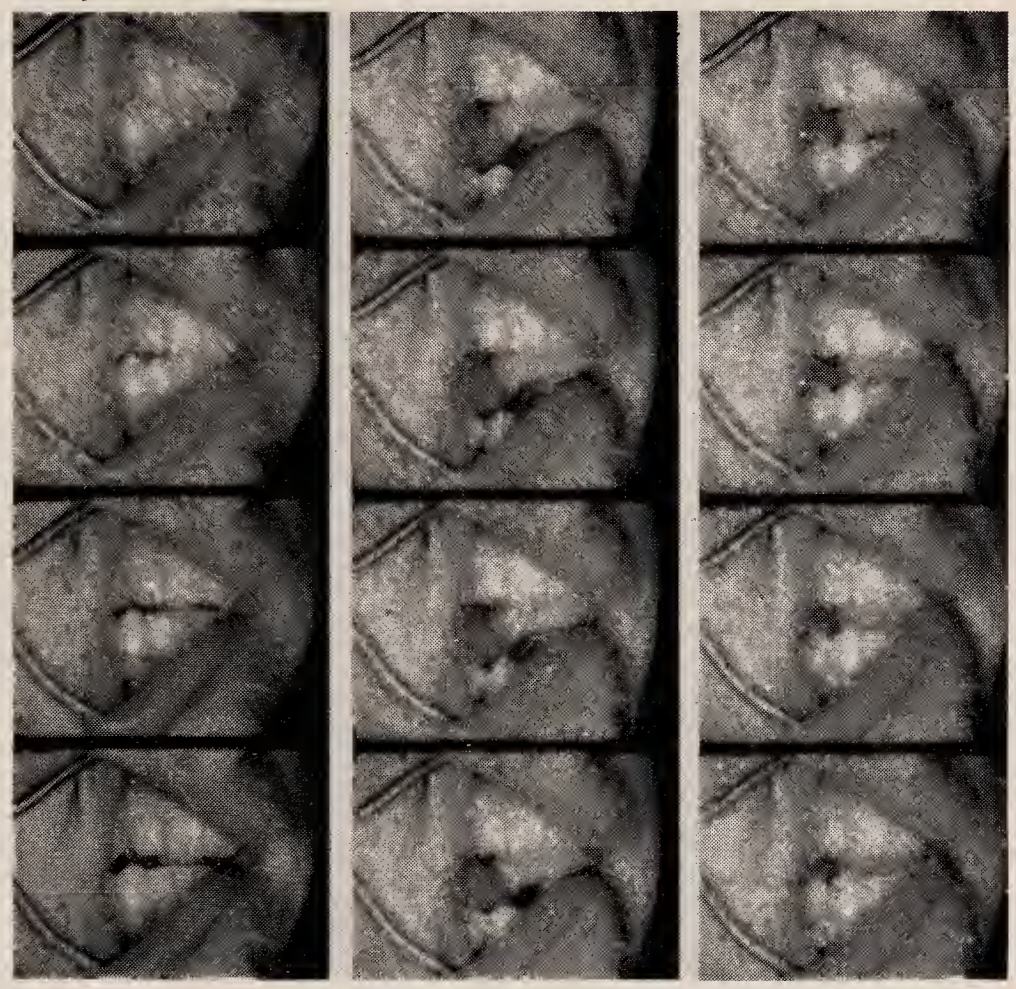
are to be stable. Film studies have clearly shown the powerful backward thrust of the lower lip of the Angle Class II individual and illustrate why, if artificial teeth are set forward in the way of this powerful lip, the denture is bound to be unstable.

Observation of functional activity is not always easy and I have been using a technique for some time, although it is still in the experimental stage, to attempt to determine the functional activity of the lips of edentulous individuals. The bite blocks are cut away from the region of the first premolars after the vertical dimension has been assessed and into this space soft alginate impression material is inserted. The fitting surfaces of the bite blocks are dusted with gum tragacanth to ensure that they are firmly fixed to the ridges. The individual is then instructed to chew up and down on the bite planes and swallow several times before the alginate sets. When the blocks are removed from the mouth, the alginate will be found to have been moulded by the action of the lips and tongue and three definite forms of such lip impressions can be recognized. Two of these are shown in *Figs.* 2 and 3.

The individual with the Angle's Class I jaw relationship produces an alginate lip impression with a forward slope when viewed from the side (*Fig.* 2). The Angle's Class II individual produces a backwards slope of the alginate (*Fig.* 3), and the Class III individual produces a form

which shows a much greater activity of the upper lip than the lower.

When the bite blocks are positioned in the articulated models, plaster may be poured over the front of the alginate to form a guide to the technician when setting the anterior teeth.



A B C

Fig. 4.—Sequences from slow-motion cine film. A, Teeth commencing to part; note comparative relaxation of corner of mouth and bulge of the cheek. B, Corner of mouth contracting to hold piece of food back. C, Teeth closing in chewing; note marked contraction of corner of mouth and cheek flattened.

THE ACTIVITY OF THE CORNER OF THE MOUTH

Film studies have shown the powerful inward and backward action of the corner of the mouth (*Fig.* 4) and also how this action is designed to prevent the escape of the food forward during chewing. In my opinion the fact that the buccinator muscle crosses the ridge posteriorly to be inserted into the pterygomandibular raphe and the powerful backward and inward thrust of the modiolus anteriorly is designed to prevent the escape of food either backwards or forwards during chewing and to confine it to the area of the cheek teeth (*Fig.* 5). The action of these two areas of the cheek should be reflected in the design of the lower denture which should always be kept narrow in the regions of the last molar and of the modiolus. If this is not done the powerful muscular activity of these areas will lift the lower denture off the ridge.

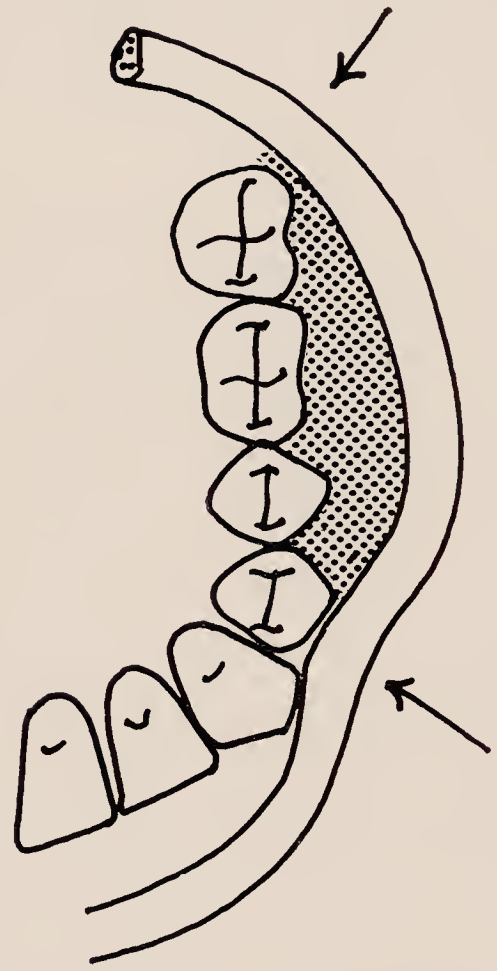


Fig. 5.—Arrows indicate areas of marked contraction to confine food to region of cheek teeth and prevent escape forwards or backwards under powerful force of chewing.

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DISCUSSION

The President, opening the discussion, said that it was interesting to have a talk from an expert in another dental specialty, particularly when he showed such a grasp of orthodontics and was very conscious of problems of tongue behaviour which were of interest to prosthetists and orthodontists alike. From the excellent films that Professor Liddelow had shown, it was quite obvious that the tongue could adapt very quickly in many cases, but there were some patients in whom this adaptation was lacking and these were a problem both to the prosthetist and the orthodontist. He liked the term 'defensive tongue' but, unfortunately, in many of the cases which were a problem to the orthodontist, the tongue was just the opposite.

He was intrigued to know whether we should continue to use the term malocclusion. A particular form of occlusion might be most satisfactory to the particular individual if it was functionally and aesthetically acceptable, without conforming in any way to an ideal

concept. The prosthetist and orthodontist had to accept this in order to obtain a stable denture.

He asked Professor Liddelow what percentage of adult patients seemed to require a 'set-up' with anterior spacing in the form of open bite because of a tongue-thrust which did not appear to modify.

He wondered whether, in years to come, the orthodontist should not hand over head-plates and models to his patients to help their prosthetic brethren in years to come.

Mr. D. G. Bunker said that he wished to ask Professor Liddelow a question which had been bothering him for some time. It referred to a Class II, division 1 case which had been corrected by intermaxillary traction or an Andresen appliance. Frequently, they had what appeared to be a Class I occlusion as a result and they chewed very happily in that position, but they could equally occlude farther back into a Class II occlusion when they were asked to do it. Fifteen years later when they came back for full dentures, in what position should the dentures be put? Should they be made into Class II again or Class I?

Professor Liddelow said that he assumed the patient was being turned from being Class II, division 1 into a protrusive chewer in the process of his orthodontic treatment. He chewed in a bite of convenience. He was not at all sold on the idea of the utterly retruded position of chewing for all patients. He had fallen into trouble in the past in voicing this in prosthetic fields. He thought that these patients could sometimes be set up to a protrusive position of occlusion and possibly they could be set up as Class I. It was only when they were retrusive that they tended to get a powerful activity of the lower lip. Whether this had any relationship to the position of the front teeth, he would not like to say. He hesitated to pass an opinion on what sort of shape the lip-impression technique would give in a patient under these circumstances.

Mr. D. H. Oliver said that it might be remembered that, a year or two ago, as a result of a paper read by a doctor who said that people were unilateral masticators, he had had a word to say about that. Afterwards he had conducted a little investigation and had found, in point of fact, that people were by nature bilateral masticators, but a great many acquired the habit of unilateral mastication. Many of the slides and pictures shown by Professor Liddelow showed unilateral mastication, particularly the early ones where he had shown the tongue's action in keeping the denture up on one side, the other side being, as he described it, the functional one.

Had Professor Liddelow made any effort to re-educate such cases into bilateral mastication, and if so, with what results?

Professor Liddelow said he thought it was usual for most denture wearers to be unilateral masticators. His experience in this was over many years of filming patients who had been filmed for purposes of illustrating how one chewed. He always approached them and asked on which side they habitually chewed; they thought for a moment and then told him. One very rarely came across a patient who wore dentures who was a bilateral masticator. He had heard it said that they should be taught to chew on both sides because this was supposed to help the stability of the denture, but he did not think it was possible from the action of the tongue and cheeks to chew on both sides at once. He thought it was possible to chew on one side at one time and one could throw the food on the other side to chew, but did not think the actual function and activity of the tongue would allow one to chew on both sides at the same time.

He had had experience of re-educating patients to chew on the opposite side, particularly in relation to the temporomandibular joint syndrome. In some of these patients, this would produce spectacular results in relation to the pain, but most of them would say that it had taken them several weeks to develop the facility of chewing on the opposite side.

Mr. Oliver said that his experience was different. He had found it possible to re-educate patients with dentures and that their denture comfort had increased on that account. He could chew on both sides at once himself.

Mr. F. Allan referred to the first part of the paper and particularly the film showing tongue behaviour in holding a fractured denture in place. He said it demonstrated how adaptive the tongue was, far more adaptive than was taught in the schools today, and the so-called adverse muscle pattern was not clearly as adverse as it had been made out to be. A few cases were untreatable, but many were rejected as untreatable and could easily be successfully treated.

Professor Liddelow's patients were, on the whole, older than those seen by orthodontists. He asked Professor Liddelow what happened to those patients who swallowed with circumoral contraction—either with their teeth apart or together—when they became full denture patients.

Professor Liddelow said that what prosthetists were trying to achieve was the positioning of the teeth in the neutral zone. Prosthetists were not worried from the point of view of the swallowing activity since in patients whose teeth were together when they swallowed this fact would keep them in place. An important factor was the backward thrust of the lip, and in these cases he would set the lower teeth further back so that the lip would not displace them and would leave a space between the upper and lower teeth to allow the tongue to come through and increase the patient's comfort.

Mr. J. K. Wilkie asked Professor Liddelow if, with the functional alginate impression of the anterior part of the mouth, he had ever recorded an incomplete overbite or its equivalent, that is, an impression with a hole in it.

Professor Liddelow said that he had not come across one yet, but would very much like to—in other words, where the tongue had come right through and met the lips.

Mr. A. Fraser asked how Professor Liddelow assessed the occlusal plane and whether, in Class II, division 2 he could reduce the overbite by setting up shorter teeth.

Professor Liddelow said this was a difficult question. When patients were rendered edentulous, they were often more concerned with their appearance than with the function of their teeth. If one were to take a patient with a natural Class II, division 2 malocclusion and set the anterior teeth in Class I relationship the crowns of the upper incisors would be very short and would tend to be concealed by the rather long upper lip. Many patients could function very adequately with a deep overbite on their dentures. If the patient had a good interalveolar distance and a good freeway

space, he might attempt to set the teeth in Class I relation. If the interalveolar distance was small, as was often the case, he would set the anterior teeth with a deep overbite and usually found that the patient would function quite well.

Mr. A. G. T. Allcorn asked if Professor Liddelow had any cases that were definitely known to be Class II, division 1 and Class II, division 2 before the teeth were extracted and if so, if there was any difference in the alginate bite recordings.

Professor Liddelow said that he was at the moment working on a series of patients and was recording before and afterwards. As far as he could see, he would not like to say between division 2 and division 1, but Class II's were producing this backward thrust of the alginate.

RESEARCH REPORTS

THE RELATIONSHIP BETWEEN LOSS OF FIRST PERMANENT MOLARS AND CARIES.

By J. D. McEWEN, W. D. McHUGH, and A. D. HITCHIN, St. Andrew's University Dental School, Queen's College, Dundee.

A RANDOM sample of 2905 Dundee 13-year-old children was examined by two examiners during the years 1960, 1961, and 1962. The numbers of decayed, missing and filled teeth were recorded and the mean DMF index was found to be 10·02. To study the relationship between the loss of first permanent molars and caries, two groups of children were selected from the sample. In one group, all the first permanent molars had been extracted, while in the other, the children had all these teeth present. The group which had lost the first permanent molars had a mean of 12·68 DMF teeth per child while the other group had a mean of 8·58 DMF teeth per child.

Since it could be argued that the missing permanent first molars were having a disproportionate effect on the DMF teeth index, a modified index was calculated in which these teeth were excluded. It was then found that children with these molars missing had, on average, 8·68 DMF teeth in the remainder of their dentition while, in the children with all first permanent molars, the corresponding figure was 4·88 DMF teeth.

It is, therefore, concluded that early loss of first permanent molars in these children was not associated with a low incidence of caries in the rest of the dentition.

THE MEASUREMENT OF PRESSURES EXERTED ON THE TEETH BY THE PERI-ORAL MUSCULATURE.

By M. S. E. GOULD, B.D.S., F.D.S., D.ORTH., Orthodontic Department, Eastman Dental Hospital, London, W.C.1, and D. C. A. PICTON, B.SC., PH.D., B.D.S., F.D.S., R.C.S., University College Hospital Dental School, London, W.C.1.

A METHOD of measuring peri-oral muscular pressure has been developed and evaluated (Gould and Picton, 1962, 1963). Transducers incorporating resistance wire strain gauges were mounted interdentally; they protruded 1·5 mm. and were, on average, 7 mm. long.

The pressures exerted by the cheeks and lips on the teeth were measured in 10 young male subjects with normal occlusions (Gould and Picton, 1964). Standard exercises were utilized to assess average forces and recordings were made from the central incisor, first premolar and first molar of each arch on the right side. The highest pressures were on the premolars. A resting pressure was found for all regions and sipping and swallowing 10 ml. of water always produced an increase in pressure above the resting level. In another study, it was found that more force was exerted on the right premolars than on the left.

In a preliminary study of subjects with Class II, division 2 malocclusions the lip cheek pressures from the right side of 6 subjects were significantly larger than those from the left side of 4 others. The pressures on the maxillary premolar were again larger than those for any other region examined. The pressure on the edge of the maxillary central incisor was larger than on the centre of its crown whilst sipping and swallowing 10 ml. of water and at rest.

Comparison of the mean pressures exerted by the 6 Class II, division 2 individuals with those from the normal group have been made and statistically evaluated. The pressures in the upper premolar and molar regions were larger in the Class II, division 2 group in all exercises, significantly so when sipping and swallowing 10 ml. of water. The lower premolar pressures in the Class II group tended to be smaller than the normal group in all exercises. The pressures in the other regions were found to be similar for both groups for all exercises.

Studies of the pressures exerted by individuals with Class II, division 1 malocclusions and Class III malocclusions are in progress, as is the development of an accurate method of measuring lingual pressures.

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TONGUE-SUCKING IN AN ADULT PATIENT

A. J. WALPOLE DAY, B.D.S., F.D.S., H.D.D., D.Orth. R.C.S.

Consultant Orthodontist, Birmingham Dental Hospital

ABOUT a year ago a most unusual patient came into my surgery for advice. That she was unusual was immediately apparent because she was 29 years old and this is strange in an orthodontic practice, but how unusual she was I was not to discover till later.

She was a very pleasant lady, good looking, intelligent, well educated and in every way well equipped for enjoying a happy life. She had been married about three years and was employed full time by a well-known firm of opticians. I asked her if she had any family and she said not and on further enquiry I was told they were just moving into a new house and there were a number of things she wished to buy for the house before settling down to raise a family.

I thought you should know the background of this case so that you could appreciate that she was just like thousands of other newly married wives.

Examination of her teeth revealed severe overcrowding of the upper and lower incisor and canine teeth. There was also linguoclination of the upper and lower molar and premolar teeth (*Figs.* 1, 2 A).

She was a Skeletal Class I and the occlusion was Angle's Class I on both sides. The incisor bite was traumatic, there being marked attrition of $\frac{1|1}{1|1}$. $\overline{1|1}$ were discoloured and gave no response to thermal stimuli. The palate was very deep but not narrow, the upper premolar and molar teeth being more vertically placed than normal. The immediate reaction on seeing such a mouth is to assume that excessive and abnormal pressure is being exerted by the muscles of the lips and cheeks on the teeth and that this pressure was not being balanced by an equal pressure from the tongue.

Fig. 1.—Photographs of three views of the models of the first patient.

There was, however, no evidence of excessive lip pressure, no tell-tale lines suggesting abnormal contraction of the mentalis muscle or orbicularis oris; in fact the lip closure appeared quite normal for someone of her age and the lip line was not abnormally high, the lower lip covering only half of the crowns of the upper incisors. The speech was also normal and so was swallowing.

I found it difficult to reconcile the overcrowding and displacement of the teeth with the normal jaw and dental base relationship, good bony arches quite capable of accommodating the 32 erupted teeth, and no apparent habit or activity to cause such a condition.

I discussed the problem with the patient who was quite capable of understanding fully the nature of it. She then said, ' Would it be because I suck my tongue ?' I said it seemed very likely but could she explain exactly what she meant. Whereupon she demonstrated to me that she folded back the anterior third of her tongue onto the dorsum of the tongue and then sucked it (*Fig.* 2B). She said she always went to sleep with her tongue in this position and had done so as long as she could remember. Asked if she sucked

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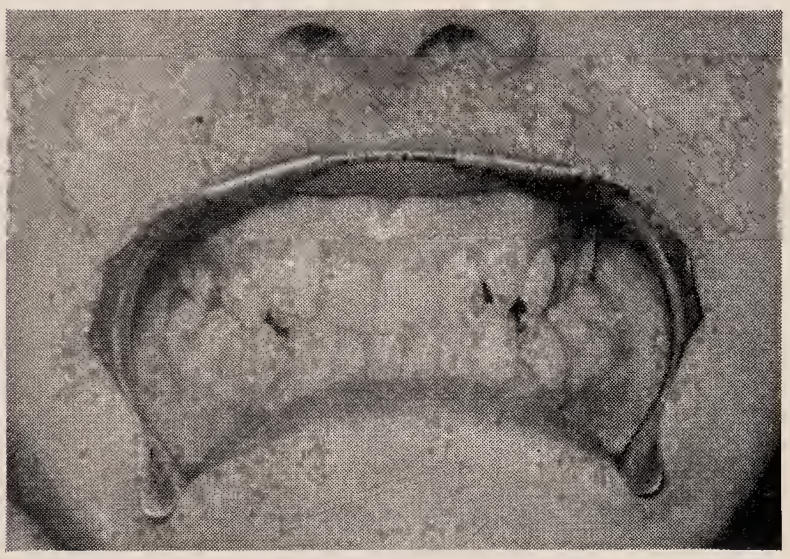
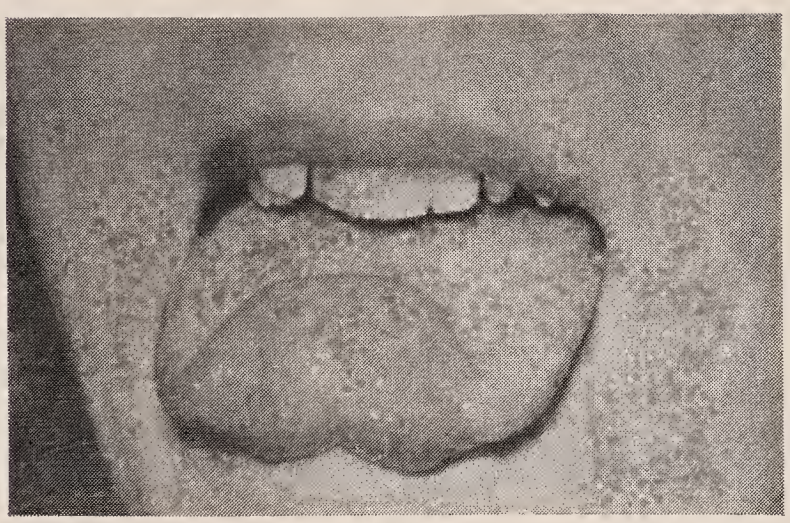
her thumb or fingers at any time she said she had not but she used to bite her nails till the age of 16. She does not smoke except for the odd cigarette now and again and eats very few sweets.

A tracing of the lateral skull radiographs confirms the clinical observations, i.e., a normal skeletal pattern with retroclination of the upper



A



B

Fig. 2.—A, Intra-oral photograph of the dentition. B, Photograph showing folding back of the tongue.

and lower incisor teeth of 10° or more and a very deep palate, the anterior part of which rises almost vertically from behind the incisor teeth. There can be little doubt that the unusual tongue behaviour is responsible for the malocclusion (*Fig.* 3).

Further light can be thrown on this case by comparing her teeth with those of a child aged 9 years who exhibits a similar condition. She also has a normal skeletal pattern, a Class I occlusion with well developed dental bases but with retroclination of the upper and lower incisor teeth and consequent overcrowding. Questioned about whether she sucked her fingers or a blanket, her mother said she made sucking noises but did not put anything in her mouth; she thought she sucked her lip. The child, however, corrected her mother and said she sucked her tongue. Questioned further she said she curled her tongue back to suck it. Asked to demonstrate this it was possible to observe the rim of the tongue turned back but this quickly became flattened as she opened her mouth.

At this point I would like to emphasize that both of these cases exhibit a habit of tongue-sucking where one part of the tongue is folded back and sucked by the rest of the tongue.

There is no question of sucking the thumb, or lower lip, or cheek, or even sucking the anterior

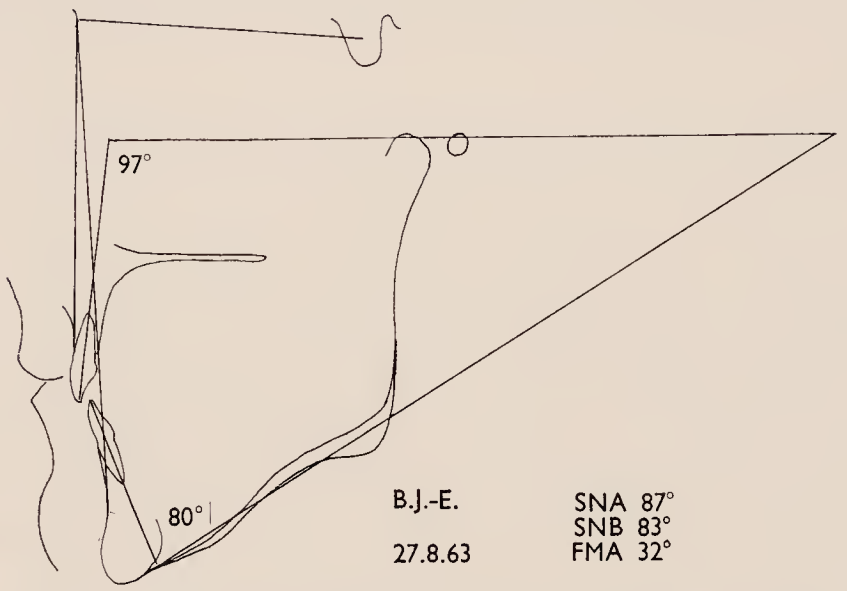


Fig. 3.—Tracing of lateral skull radiograph of the first patient.

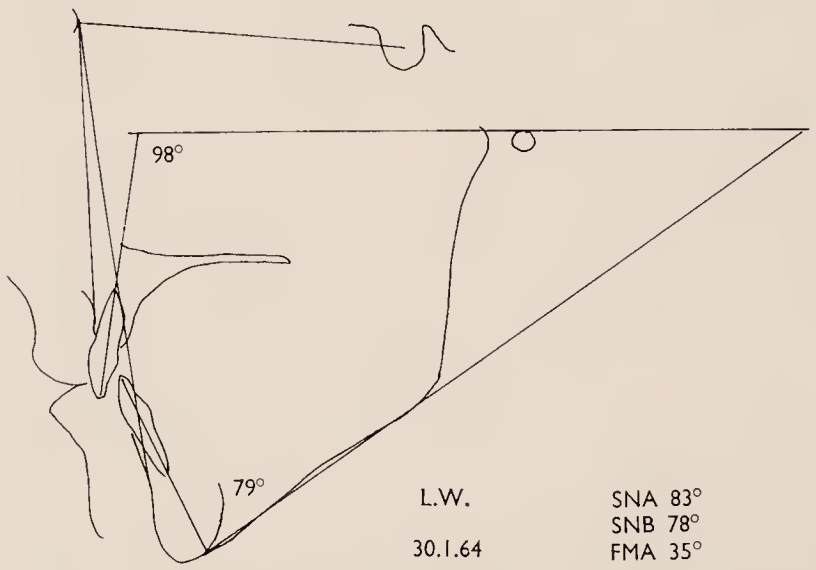


Fig. 4.—Tracing of lateral skull radiograph of the second patient.

teeth as some children do, which is often misnamed tongue-sucking. The term ' tongue-sucking ' should be used solely for the purpose of describing such cases where the tongue is sucked by the tongue.

Tracings of a lateral skull radiograph show a remarkable similarity with the other case, the retroclination of the incisor teeth being slightly more marked (*Fig.* 4).

I believe that the habit of tongue-sucking occurs in children more frequently than is generally realized; it is usually accompanied by a habit of holding a small soft toy or piece of furry material in their hands. Fortunately the habit seems to stop fairly early in life but does persist in a small number of cases to the age of 9 to 11 years. It is these rather rare cases which, when treated with expansion appliances, remain in good occlusion when the expansion appliance is removed, for the

simple reason that the habit has been stopped by the wearing of an appliance. The inference is that if the habit had stopped naturally, the teeth might have corrected themselves without assistance.

In the somewhat limited time at my disposal I have not found any references to this tongue-sucking habit in the literature but I am sure some of you will have encountered similar cases in your practices or even in your own families and I would be very pleased to hear about them. I am sure that we still have a great deal to learn about the activities of the tongue, both normal and abnormal, whilst other circumoral muscles are in the rest position or performing their normal functions.

It is, after all is said and done, the activities of the tongue in conjunction with these other muscles which finally determine the size and shape of the dental arches.

DISCUSSION

Mr. V. S. Iyer asked the author if he had observed any speech defect in the patient.

Mr. A. J. Walpole Day, in reply, said that he had made careful inquiries about this and had listened carefully. There had never been any suspicion of lisping or other speech defect in either patient.

The President (*Dr. W. J. Tulley*) questioned whether the tongue-sucking was an aetiological factor in this case. He thought there was a tendency to Class III malocclusion and a tendency to have dental bases which were not adequate to accommodate the teeth in good alinement. He would not suspect the tongue-sucking habit in this case.

Mr. J. D. McEwen said that the position of the tongue described by the author was that used in the retroflex ' r ' used in Somerset. He wondered whether more of these cases might be found in Devon and Somerset.

Mr. A. J. Walpole Day, in reply, said that he would be interested to hear if there were any other cases. In the first case Mr. Brenchley had shown, there was a distinct crease across the front of the tongue and also a severe retroclination of the lower incisor teeth. He wondered whether there were any connexion between that case and the cases he had shown.

Mr. M. L. Brenchley said that he did not think it necessarily had anything to do with any habit. He thought that, if there were an active habit, the incisors would be mobile.

The author had commented on the traumatic relationship of the incisors in the adult patient but had not said whether that had been judged on mobility.

Mr. A. J. Walpole Day said that it had been judged on attrition and on the fact that they were dead teeth. There had been no mobility.

Mr. S. Haynes said that he had noticed that the author attributed the deep space to the tongue habit. Did he not think that the deep intermaxillary space might be associated with yet another form of adapted tongue behaviour?

Mr. J. H. Gardiner asked if there was any explanation for the vertical positioning of the rugae other than the tongue. This rather vertical positioning of the rugae in the anterior part of the palate was seen in a patient with an Angle's Class II, division 2 malocclusion. The child had not shown this.

Mr. A. J. Walpole Day, in reply, said that in Class II, division 2 cases the vertical position of the upper incisors was due to excessive lip pressure and a high lip line. Neither of his patients had a high lip line nor did they show any evidence of excessive lip action. There were no lines about the lips indicating tension.

Mr. A. S. Lewis asked if the author had observed the action of the tongue in swallowing. He remembered a Class II case with an especially high palate. In swallowing, the tip of the tongue went to the apical area of the incisors. The undersurface of the tongue contacted the lower lip. It appeared to be in the same position as if it were folded back, the tip of the tongue going across the roof of the mouth.

Mr. A. J. Walpole Day said that he could not answer with precision. As far as he could tell, the swallowing behaviour was normal but he would not be surprised if part of the tongue was folded back during swallowing, especially in the child.

AN AMERICAN VIEW OF REMOVABLE APPLIANCES

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THERE are many reasons why I am happy to appear before this society: your president, Jack Tulley, is an old friend; many others of you I have known for several years; and several of you have visited us and a return visit is due. Then too, I have never appeared before a British dental society and Plymouth seems a good place for an American to start.

There have been a few difficulties with the title and the concept. The original title suggested was *The* American view . . . which I asked to have changed to *An* American View . . . . No claims for correctness are made and the views presented are simply one man's opinions. Furthermore, mine is not, I believe, a typical American view; therefore one should not condemn my compatriots for any errors of mine.

I. WHY MIGHT AN AMERICAN HAVE A DIFFERENT ATTITUDE TOWARDS REMOVABLE APPLIANCES?

Historical Reasons

1. Multibanded techniques are older than American orthodontics, but they had to be developed and perfected. Much of this improvement was the work of Angle, our most famous orthodontic teacher. Angle was opposed to the crude removables of his day; the fixed removables of Jackson and Kingsley, for example. The functional jaw orthopaedics of Andresen had not yet been presented. In the excitement and thrill of developing and mastering a succession of ingenious elaborate precision multibanded appliance systems, many American orthodontists forgot to ask an important question: 'Have there been any new developments in removable appliance techniques?' Andresen had a great new concept, but Americans were too excited with their own new gadgets to listen at that time.

2. For all Angle's brilliance he seems to have been suspicious of any mechanics not the direct result of his own fertile mind. He was as scornful of the fine work of Case and Dewey as he was neglectful of new ideas across the Atlantic. He taught dogmatically, forcefully, arrogantly, and skilfully. Indeed he trained superbly a whole generation of American orthodontic teachers, blinding them by the sheer brilliance of his ideas and methods. We will be forever indebted to and hampered by the Angle tradition.

Cephalometrics

1. Broadbent, one of Angle's pupils, presented us with the principles of cephalometrics at the very time American orthodontists were adopting the edgewise mechanism. With cephalometrics one could detect more readily the skeletal and dental elements of a malocclusion. Further, it was now possible to test how precisely an appliance did what it was purported to do. Cephalometric methods had an impact on appliance systems in two ways: (*a*) they showed clearly the virtues and faults of the different mechanisms, assigning a specific role or limitation to each, and (*b*) they sharpened our diagnostic skills. Both led to the desire for more refined tooth positioning methods and hence the need for precision attachments. With cephalometrics, too, we came to have a clearer idea of treatment aims: the more precisely you can define your task, the more demands you make on your appliance.

2. Cephalometrics has many uses: (*a*) to study facial growth; (*b*) differential diagnosis; (*c*) to express in mathematical analogues our treatment aims; and (*d*) to assess critically how well we achieved what we set out to do. Studies of this latter type are, as you know, abundant in the American literature and have had an effect on the popularity of some appliances, e.g., many have abandoned the twin-wire appliance simply because it has been shown inadequate for important tooth movements such as incisor root torque and paralleling of bicuspid and cuspid roots. Obversely the precision multibanded techniques have become more favoured since one could prove he was able to do that which he intended.

Since most American orthodontists use cephalometric analysis routinely on all cases, the effect has been to reinforce the popularity of the 'edgewise-type' mechanism.

They have a certain 'Stigma' attached to them

1. The first encounter for the average American orthodontist with a removable appliance is not while in training but likely a transfer case in

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practice. The patient is apt to come from an ill-trained non-specialist dabbling in orthodontics. Such a dentist regards mastering one of the precision systems as hopeless in his general practice and turns to the European literature to learn what seems to him a simpler method. The orthodontist receiving the transfer patient condemns outright both the dentist and the appliance, whereas he might better reserve his criticism for the man alone.

2. There is no strong advocate of their use. Thus they lack, in America, the prestige of a famous clinician's name. To use removable appliances solely is, then, a form of isolation from one's colleagues using more conventional methods. There is a paucity of study clubs and short courses devoted to removable appliances. Furthermore, those which exist are apt to be out of the mainstream of American orthodontics.

3. In recent years a number of American children returning from abroad and migrants have come with various removable appliances in place. We are expected to continue the treatment and our inability to do so frustrates and prejudices our attitudes towards the appliance. In the many transfer cases sent to me from Europe there has never been an accompanying treatment plan and only rarely a note requesting continuance of the therapy.

4. To summarize—our casual exposure to the methods of removable appliances is erratic, not comforting, and tends to reinforce our prejudices against them.

II. ARE THERE PROBLEMS IN THEIR USE (FOR AN AMERICAN)?

Literature

1. At Michigan we are, perhaps, more interested in removable appliances than most American orthodontic departments. Our use of the appliances and our interest relates to two former staff members: Professor Anders Lundström, who was a visiting professor for one term, and Professor Egil Harvold, who was associated with our department for about eighteen months. We teach a variety of activator-monobloc type appliances and have done so routinely for about 10 years. However, we make no claim to great skill in their use. Sometimes the cases work out well, other times we are completely unsuccessful. We are at a loss to know why our success varies. It is not a matter of patient co-operation, for by actual comparison with extra-oral traction appliances (another removable, incidentally) there seems to be no difference. When we turn to the literature help is not forthcoming. Hotz of Zurich is reported, in a recent British paper, to get 40 per cent successfully treated cases with his version of removable appliances. Not unlike our own experience. But which 40 per cent will respond? Who can tell us?

2. The best way to learn how any appliance works is to test its efficacy with quantitative cephalometric findings. This method, cephalometrics, has also come to be the standard way of communication amongst clinicians—the best means of persuading others of one's methods. Despite the widespread use of functional and other removable appliances, the English language literature doesn't yet contain a detailed analytical study of how they effect a treatment.* There are good individual case reports, hundreds of new clasps and mechanical innovations, but not one serial study of the results of, let us say, 25 consecutively treated cases. My students can read a number of good papers on any of several other systems of therapy, but there is a paucity of proper studies on the removable appliances. Just one thoroughly careful analytical paper would convert more Americans than a dozen individual case reports.

In *My Fair Lady*, Eliza Doolittle sang, ' Words, words, I'm sick of words: give me love.' She wanted performance. Words have an important role in the scientific literature—to introduce ideas, concepts, and opinions. But we have reached the stage, long ago, in orthodontics where we require data as proof. Words can only be argued. Data are quantitative, reproducible, and hence testable.

One must compete with Colleagues using the more familiar Multibanded Precision Methods

1. There are advantages and disadvantages, but it sometimes requires some persuading of patients, since they, like all of us, are suspicious of that with which they are unfamiliar.

2. On the other hand, patients frequently ask for treatment without bands.

We tend to view them as Adjuncts to our Primary Systems of Treatment

1. Often the itinerant American orthodontist is asked in Europe, ' Why don't Americans use removable appliances? ' We do, a wide variety are used routinely, e.g., head gears, neck straps, bite plates, stabilizing plates, tooth positioners, obturators, Crozat appliances, etc. Most of these are considered adjuncts to some multibanded system, rather than a substitute for such a method.

2. The result is that we often fail to appreciate the wider uses to which they might be put.

III. WHAT IS THE ROLE OF ECONOMICS IN AFFECTING ATTITUDES?

There are those, both in Europe and America, who claim that each type of appliance has a role by serving different parts of the economic spectrum: bands for the wealthy, removables for

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* Since this paper was read a fine paper by Grossman and Moss, *Dent. Practit.*, 1964, **14**, 405 has appeared.

those less fortunate. This seems a poor argument since we only have *time* to sell and many cases treat faster with full banded therapy than with removables. In neither country is the orthodontist primarily a middle man for the laboratory or supply house.

I do not know which appliance I would use were I to practice in the Greek economy, how I would compromise my standards of treatment with the necessity to earn drachma. Similarly, it is difficult to say what effect a state health scheme with established fee schedules has on the choice of appliances. The possibility exists that such factors may affect our thinking more than we like to admit. Walt Whitman : 'Our attitudes are the victims of our experience.' The American private practitioner may simply have the luxury of imposing on his patients more full-banded appliances than does an orthodontist working under the restrictions of a fixed fee schedule. He may also be handicapped by this method of practice, since he is rarely challenged to do much with little. Surely the European orthodontist is more aware of the community needs while the American often assumes responsibility only for those who enter his office. Thus is posed a basic philosophical question:

IV. 'IS IT BETTER TO GIVE SOME TREATMENT FOR MANY OR THE BEST TREATMENT FOR THOSE MOST NEEDING IT?'

The American orthodontist concerns himself with the most difficult problems, thus he uses complicated appliances and treats a lesser number well. The American problem is not (in our American view) how to adopt removable appliances but rather how to get our service to those with less income. Removables are only the answer, to us, if no compromise in quality is involved. Public health research thus is different in the U.S. (time and motion studies, relapse, prefabricated appliances, etc.).

The European has the converse view but runs the danger of feeling smug about more cases treated without defining what the cases are and what is *treatment*. By any standards, except those exhibited in our country by the most unimaginative and bumbling bureaucrats, one cleft palate child treated is better than ten treated simple crossbites. The statistics may not look so great; the contribution to society seems far superior.

I ask a simple and naïve question: Would our attitudes not change, if we each were to exchange countries? If such is the case, should we each not examine our prejudices so firmly held. I submit that the basic question may not be one of one appliance versus another, but how best to serve the society which gives us a legally licensed monopoly. On this point my attitude may differ more with yours than on the worth of removables.

V. ARE THERE ADVANTAGES IN THEIR USE (FOR AN AMERICAN)?

Indications and Advantages of Removable Appliances

One might think from all the preceding that the author is disenchanted with all types of removable appliances. Such is not the case and I list here some of their indications and advantages as I see them.

1. They are of use for patients who come infrequently and from a great distance, for they are safe when left in place.
2. They may be used advantageously for patients with rampant dental caries or other gross problems of oral health.
3. They are useful for certain crude movements of teeth.
4. They may be used as retainers after active therapy is completed.
5. Certain of the removables can serve as an aid in conditioning some reflex activities of the oral facial musculature, e.g., a hyperactive mentalis with a modified oral shield.
6. They are useful when redundancy in treatment is planned, e.g., two-phase Class II therapy. Here I like to use a modified monobloc or activator in the mixed dentition and a full-banded edgewise to complete the case.

It should be noted that the indications and advantages listed above do not apply equally well to all types of removables; thus the activator may be safe when left in place but certain of the so-called ' fixed removables ' could conceivably do damage.

Disadvantages

There are certain disadvantages for removable appliances as a group. It should be pointed out that one can often use an appliance with some success in treatment even though it is disadvantageous to do so and one might better use another system.

1. The removable appliances are imprecise in action (this is not always a handicap).
2. They are very time-consuming for some procedures.
3. It is more difficult to transfer a case well when a removable appliance of your own design has been constructed (this comment probably is far more pertinent in the United States of America than in Great Britain).
4. To plan a treatment using removable appliances denies complete therapy for some cases which need it if the correction is to be retained.
5. Certain tooth movements simply cannot be carried out by removable appliances.

Contra-indications

In my opinion any removable appliance is definitely contra-indicated if any one of the three

following tooth movements is necessary for successful treatment:—

1. Axial movements of teeth.
2. Rotational movements of teeth.
3. The establishment of an occlusal orientation.

VI. WHERE DO I USE, ROUTINELY, REMOVABLE APPLIANCES?

Planned Redundancy in Treatment

There are many advantages to treating severe Class II malocclusions in two stages: retraction of the maxillary incisors reduces the chances for accidents, it is advantageous to establish normal muscle function as soon as possible, and the longer view of the growing face makes the final fitting of the teeth to the patient's pattern easier. Since it is not advantageous to leave bands in the mouth for an extended period of time, one can begin Class II therapy with an activator or monobloc type appliance in the early mixed dentition and do the final niceties of tooth positioning with a full-banded mechanism after the arrival of the second permanent molars. The result is better than that which can be achieved by the removable alone and, in my opinion, is better and more efficient than when treated with the precision mechanism alone in the young adult dentition.

Primary Treatment of some Class II Malocclusions

Some malocclusions can be treated solely with removable appliances to good advantage. I like to use the classic activator as the primary appliance if the following conditions obtain:—

1. A good lower arch with no crowding.
2. A flat mandibular occlusal plane.
3. A moderately deep bite.
4. The mandibular incisors upright and not tipped too far labially.
5. The lips tending to stabilize the maxillary incisors.

The choice for early Class II treatment in my mind is between the activator and the classic Kloehn face bow and neck strap. I use the activator when the above conditions obtain and the face bow and neck strap when there has been marked mesial drifting of the maxillary buccal segments.

Retainers

Even when a Class II case has been treated with multibanded precision techniques the loose removable appliance, e.g., activator, makes an excellent retainer.

As I have indicated earlier the modified oral shield can also be used as a retainer, particularly if there is a residual abnormally hyperactive mentalis muscle which may destroy the incisor correction.

VII. WHAT IS THE EUROPEAN VIEW OF BANDED APPLIANCES?

The European attitude towards American multibanded precision appliance systems has not been examined in this paper, but your views on this proposition might seem as strange to me as some of my attitudes about the removable appliances do to you. I believe, however, that the trend today is towards more agreement about appliances but that we are still apart in another area, namely, what is treatment? The many state health schemes in Europe encourage the idea of doing something for as many as possible. No one can dispute the merit of extending orthodontic services to all of the people, but putting an orthodontic appliance in a child's mouth is not a service unless it improves his occlusion, appearance, function, or speech. Many times half-way treatment is worse than no treatment. Malocclusions often are stable whereas half-treated or maltreated cases are always unstable and hence often result in periodontal disease or temporomandibular problems in middle age. In America we have concentrated on perfecting orthodontic treatment with the result that the methods have been time-consuming and hence expensive. The problem in America is to keep the quality of the treatment high while lowering the cost. This is being done now by more simple methods, improved timing of treatment, prefabricated appliances, and research on the nature of facial growth and occlusal development. In Europe, I predict that efforts will be made to improve the quality of the treatment without diminishing the number of children receiving it. This is a big problem in those countries with state health schemes and fixed fees. Bureaucrats know very little about the economics of dental practice and often the government fees are too little to allow enough time to treat a case well or to treat it with a multibanded precision appliance. Perhaps we each have a fault: some Europeans confuse putting a piece of acrylic in a child's mouth with the best orthodontic treatment for that child while some Americans go to costly and heroic procedures when for some children a simpler approach is available. We will always have difficult cases and easy cases and we should always keep the very highest standards for all children. We must not let our desire to treat many deny good treatment to those desperately needing it. Nor can we deny orthodontics to all just because we have not yet devised the methods to do it efficiently.

CONCLUSIONS

Much is yet to be done in orthodontics on both sides of the Atlantic. I do not regard the division now as one of attitudes towards appliances primarily but rather a difference of opinion as to

what is good orthodontics. This latter problem is a philosophical one and may be more difficult to resolve. The physician knows when he has treated a disease for the fever and other symptoms have subsided and are gone. We cannot express malocclusion in terms of degrees as we can a patient's temperature, nor do we yet have detailed studies of how much periodontal and temporomandibular disease orthodontics causes. When we know more about relapse, stability of treated cases, and troubles induced by orthodontics we will be in a better position to decide which cases must be treated perfectly if they are to be maintained and which may be left part way completed without trouble. The differences in attitudes towards appliances seem to be diminishing but the problem of how far to treat a given case and how to get good treatment to all the population knows no geographic boundaries.

My view is simply this—I will use any appliance that will work to get the job done. This attitude forces me to use a variety of mechanisms, including removables of several sorts. I believe that removable appliances have a place in the orthodontist's armamentarium but only if they are used in conjunction with other appliances to effect the tooth movements difficult or impossible to achieve with removable appliances alone.

DISCUSSION

Dr. J. R. E. Mills, opening the discussion, said that he was surprised that Professor Moyers had seemed almost to equate the removable appliance with the Andresen system. Practitioners in England used the Andresen rather less and other types of removable appliance with auxiliary springs rather more. Did he use the traditional removable appliance, retained by clasps and carrying springs?

Apart from questions of fashion and wealth, there were two reasons for the difference in outlook in America and Britain. One was the fact that the Americans liked an appliance which was a system, which would do everything. Some people claimed that the removable appliance would do everything, but he was not one of them. Such a claim was unwise. They were excellent in their place, but they had a limited place. The second reason for the difference was that in America orthodontics was entirely a specialty, whereas in Britain it was very largely a general practice activity. Both methods had their advantages. Both had their disadvantages.

British orthodontists were perhaps not quite so attached to the cephalostat. They did not believe in positioning teeth quite so precisely. In most cases they placed the teeth as well as they could, but Nature always had the last word. They were therefore less inclined to go for precision.

However, there were exceptions. He agreed with Professor Moyers that in an apical movement there must be precision and it could not be done with removable appliances. With rotations there had to be precision. One had to over-rotate. This could not be done with removable appliances, although some improvement could be obtained.

The removable appliance was of value in crude movements. It was useful where such movements were all that was required. It was also very useful where such movements were part of what was required, giving better anchorage in the earlier stages of treatment, but giving way to banded appliances for the final stages.

Finally, he was very interested in the use of the vestibular oral screen in cases with mentalis contraction. He was reminded of a somewhat similar appliance attached to molar bands shown by Brodie in 1942. Brodie had said that when he took it out the teeth returned to where they had come from.

Professor R. E. Moyers, in reply, said that Dr. Mills was correct in saying that in his paper the author had tended to equate removables with the Andresen. He had not realized this until he had read the paper for the twentieth time that morning. He did indeed use a type of fixed removable for retraction of the anterior teeth in early Class II treatment with extraction. It was a combination of something presented by Heath and Philip Adams and modified by Harvey Jenkins.

The point about the Americans wanting an appliance which was a system was well taken. He had assumed that the Society knew that orthodontics was a specialty in the United States. From 1965 it would have to be legally. The American Dental Association had passed a rule to the effect that no one could call himself an orthodontist unless he had undergone proper graduate training. The public now knew that.

They could talk for a long time about the precise positioning of teeth at the end of treatment. The best answer would be found in a series of papers he had written on relapse and retention. They had come to the conclusion that there were some cases where precise positioning was essential and others where it was not necessary.

Dr. Mills had been a little incorrect to confuse the oral screen the author had shown with Dr. Brodie's. Dr. Brodie's appliance had been put in at the start of treatment, in the mandibular arch. It was used to help hold the lower molars back and to keep the mentalis away from the lower incisors. The oral screen the author had shown the Society was used at the end of treatment of a Class II case in which the lips had not been conditioned by the new incisor positions sufficiently to cause the complete obliteration of an unwanted mentalis pattern. It did not always work, but he knew before he started whether it would work. The cases in which it would work were apparent when it was first inserted, because the muscle would act just as predicted. If they quietened down with it in place, the chances were overwhelming that the lips would adapt to the appliance and thus not seriously challenge the overjet correction.

Mr. V. S. Iyer asked whether Professor Moyers considered that the real difference between the British and American systems lay not so much in the appliance therapy as in the objectives of treatment. He pointed out that the Professor had remarked that he was ' not quite satisfied ' with the result in the Class II case treated with an activator. British orthodontists would have been perfectly satisfied with the result achieved. They were quite satisfied if they obtained

posterior interdigitation, a good incisor relationship, and a fairly stable occlusion; minor rotations and even slight crowding was acceptable.

Professor R. E. Moyers thought that Mr. Iyer had misunderstood one of his remarks. He had been satisfied with the case, otherwise he would not have brought it across the Atlantic.

He did not believe that he and Mr. Iyer were too far apart. He thought that a sentence he had used in his paper answered Mr. Iyer. The more precisely one's aims could be defined the more demands one was apt to make of one's appliance. A person who started by saying, ' This is the only appliance I have. I will use it ', and diagnosed as he went along did not have a precise idea of his objective. No orthodontist yet had a very precise idea of which cases retained and which relapsed. Given that precision, many appliance techniques would be cast aside.

The President said it was interesting to note that the Professor had referred to ' his American eyes '. The Professor was of Dutch origin. Mr. Iyer was from Asia. The patient was a Pole. This emphasized the ethnic problem in looking at dental irregularities and assessing what was the best dentition for the individual patient.

Mr. H. L. Leech asked what was the average length of treatment time of the type of Class II case which the Professor had shown? How many cases would the American orthodontist have under treatment in one year?

Professor R. E. Moyers, in reply, said that he would answer Mr. Leech's question—how long did treatment take?—by asking how one measured how long it took. He measured it in chair time, not by the calendar. In the two cases he had shown there had been 4 years of treatment, measured by the calendar. There had been 3 years of active treatment and 1 year of retention before the last cephalogram had been traced. In terms of chair time it had been only a few hours.

He did not think that the average American orthodontist, using multibanded appliances and waiting until 12 to 14, treated many patients, but they were treated well. A very good friend of his had once told him that he could not handle any more than 60 patients. With two assistants, he could not handle any more and treat them as he wanted to. A friend who had listened to the conversation said, ' You might as well quit. If 60 is all you can help, you have no excuse for being in orthodontics '.

Mr. J. C. Stephenson said that he was now using ready-made extra-oral attachments of American origin. This enabled the apparatus to be assembled more speedily and as a result Andresen appliances were probably being used less. Was this Professor Moyers' experience?

Professor R. E. Moyers said that the Andresen had never been popular in the United States. Everybody used headgears and extra-oral traction. He was considered very strange in the States for occasionally using activators.

Mr. C. P. Briggs said that it seemed that American orthodontists would frequently extract four first premolars in the type of case in which British orthodontists would merely extract two upper first premolars. This seemed to be due to an American reluctance to accept a Class II molar relationship.

Professor R. E. Moyers said that the general supposition was correct. He would not presume to speak for all American orthodontists. He would merely say why he personally did not do it. He had noticed from the relapse study which they had just completed that only one man in the department avoided relapse in cases when he extracted upper first bicuspids only. This man was much more critical of the cases in which he had extracted upper first bicuspids than the other members of the department. In general treatment he extracted upper bicuspids only in cases where there was a long maxilla and rather long cranial base.

He himself was far more apt to extract upper second molars and put extra-oral traction on the first molars, because that did not present the same space closure problem.

Mr. S. G. McCallin asked if the crowding of lower incisors found following the loss of upper first premolars was very much more severe than the crowding found following treatment with loss of upper second molars. In his hands the distal movement of the upper buccal teeth and reduction of an overjet had often been followed by severe lower incisor crowding, whereas in the original condition there had not been lower arch crowding.

Professor R. E. Moyers said he would extract upper second molars only where there was a flat occlusal plane, a solid and intact lower arch, and in the permanent dentition only. Given those rigid conditions one would not see many cases, and one would not see too much crowding in the lower segment.

TWO UNUSUAL CASES OF FACIAL ASYMMETRY

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SOME degree of facial asymmetry is common to us all. This is only of importance when the degree of true or apparent asymmetry is such as to be obvious to the casual observer.

There are many causes of facial asymmetry, perhaps the best known being those due to first arch deformities, the chief manifestations of which are a failure of the mandible on the affected side to attain its full and normal development commonly associated with accessory auricles and other secondary deformities. Facial asymmetry due to unilateral hyperplasia of the condyle is also seen.

Apparent facial asymmetry can also be caused by facial-nerve palsy, especially where the muscles on the affected side have been allowed to stretch.

HEMI-HYPERTROPHY OF THE FACE AND TEETH

Reports of this condition with its associated dental malformation are comparatively uncommon in the literature. Rushton (1948) gives an extensive review of the literature, going back to 1863, and he himself reports 3 severe cases. He states in this paper that there are numerous cases of hemi-hypertrophy of the face and hemi-hypertrophy of the body in which no reference is made as to the size of the teeth. The scarcity of reports of this condition thus might be due to failure of the investigators in some of these cases to appreciate any change in the dental condition.

In nearly all the cases reported there has been precocious eruption of the deciduous and permanent teeth on the affected side. It would appear that the canine is the most affected tooth but that its increase in size is rarely more than 50 per cent bigger than the unaffected side. The upper central incisors are not usually involved. Professor Rushton believes that this may be due to their separate development from the tissues of the fronto-nasal process. He also states that the second molars are not usually involved in the condition and that little is known of the condition of the third molars. In many cases the enlarged teeth were of abnormal form, and Rushton's hypothesis is that this may be due to an unequal growth of the mesoderm part of the tooth compared with the ectoderm.

Burke (1951) reports a further case in which the hypertrophy of the face and teeth was associated with absence of the second premolar and second and third permanent molars on this side.

Many theories have been given as to the cause of this condition, some authorities considering this to be due to atypical twinning, but I would have thought that this could only apply when the whole body was affected. Professor Rushton surmises in his paper that the cause of the condition might be the result of the removal of one or more factors which normally control the rate of self-proliferation and differentiation in the area. I am by no means qualified to comment on the validity of the various theories that have been put forward to explain this condition, but I would like to put forward the suggestion that the condition may be due to a localized increase in the blood-supply to the affected area, possibly due to some fault in the control mechanism. This, of course, would have to be present from before 5 or 6 months of foetal life, and in the case that I am about to report would certainly need to be continued until the seventh or eighth year. Perhaps this is an over-simplification of the problem, but it would, to my mind, account for the precocity of the eruption of the teeth and also of the increase in size of the affected part.

The following (*Case* 1) is a case of true hemi-hypertrophy of the face associated with hypertrophy of the teeth on the affected side.

CASE REPORTS

Case 1.—This patient was referred by her dental surgeon at the age of 7 years. He had noted that the development of her teeth on the left side was some 3 years in advance of that on the right side. The permanent canine was beginning to erupt and this tooth appeared to be of abnormal form.

The mother, a trained nurse, stated that the asymmetry of the face was first noticed at 7 weeks but that it was thought to be within normal limits. There was no history of any birth trauma. As the child grew the condition had become slightly more noticeable and occasionally the child was embarrassed by people telling her that she had a swollen face. The deciduous teeth on the affected side (left) had erupted well before those on the right side, but unfortunately no accurate record had been kept of this.

On examination the child appeared to have a slight swelling of the whole of the left side of the face, which

Presented at the Country Meeting held in Plymouth on 22 May, 1964.

was not, however, at the time very pronounced (*Fig.* 1). Her dental condition at this time was, however, of interest. On the left side the upper left canine was beginning to erupt and was a tooth of abnormal size and shape. The upper left premolars were erupted but on the right side the deciduous teeth were still present. A similar condition was shown in the lower arch but the lower canine was of normal form.

The patient has been seen at yearly intervals and is now aged 11 years. As can be seen from *Fig.* 1, the facial enlargement has not become markedly worse, though there is undoubted enlargement of the left side.

A B C

Fig. 1.—Photographs of the first patient at (A) 7, (B) 8, and (C) 9 years.

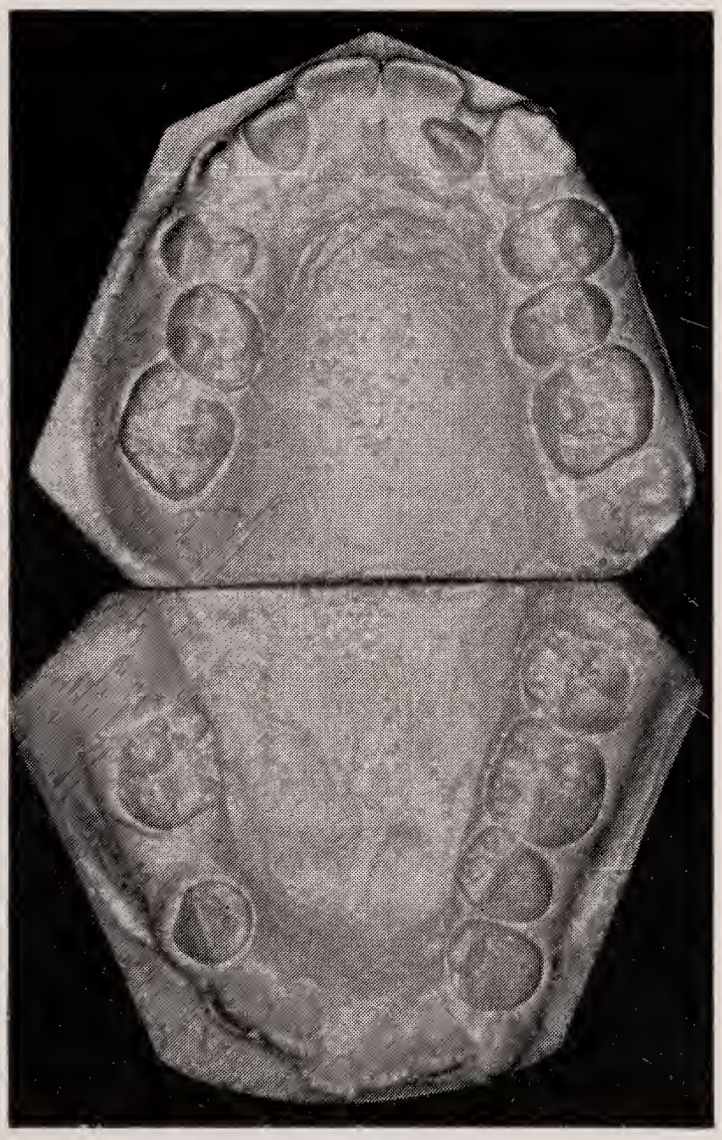

Fig. 2.—Models of the first patient at 10 years.

The models (*Fig.* 2) show the precocious eruption of the teeth on the left side compared with those on the right, and the increase in size which is most marked in the canines and premolars but is also present in the first permanent molars and lateral incisors. The X-rays (*Fig.* 3) show that the condition is also affecting the wisdom teeth, the lower left wisdom tooth being at a more advanced state of calcification than that on the right, and also of greater size. Comparative measurements of the teeth are given in *Table I* and show that the upper left canine is some 0·5 cm. larger than the right, the second premolar is nearly 2·5 mm. wider on the left, and that all the teeth except the upper central incisors and the lower central and lateral incisors are affected to some degree. Unlike Mr. Burke's case, the tongue does not seem to be affected by the condition and the child is of normal intelligence.

Treatment at the moment is to be confined to the treatment of malocclusion.

Case 2.—In this case the asymmetry of the face is more apparent than real. However, I think the case is of some interest. I am indebted to Dr. Mayon-White for the history of this case.

The mother first noticed that at the age of 5 months the child was unable to hold her head up. The general practitioner referred her to the orthopaedic department who in turn referred her to the consultant paediatrician. The birth was apparently normal and at full term; there were no birth injuries or cyanosis. Normal progress was made with feeding and there was no vaccination or immunization carried out, nor could any family history of muscle or bone disease be elicited.

On examination at this age some weakness of the left side of the face was suspected. Although the right sternomastoid muscle was palpable, the left was

apparently absent. There was no evidence of weakness of the arms or legs and a radiograph confirmed the absence of the left sternomastoid muscle. A full central nervous system examination elicited no abnormality.

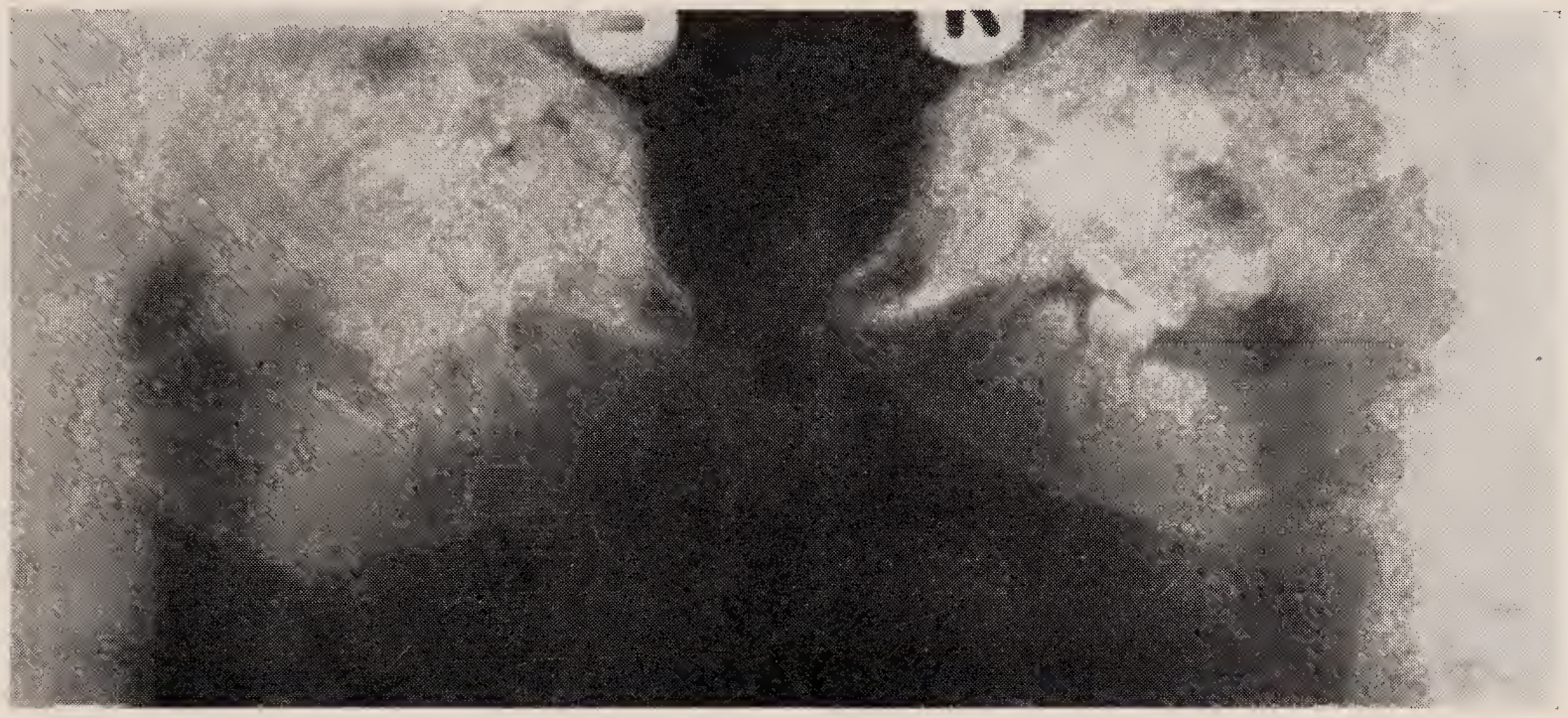

Fig. 3.—Lateral jaw radiographs of the first patient at 10 years.

The patient was seen again at the age of 3 years by the paediatrician. It was noticed that she was holding her head on one side and that there was some facial asymmetry. The left carotid pulse was clearly visible and she was unable to get up from a lying position without first turning on to her left side.

At the age of 5 years it was noticed that she was not walking correctly and when examined by the paediatrician some flaccid weakness confined to the left lower limb was noticed. The leg was a little shorter and slightly wasted, the knee- and ankle-jerks being slightly less brisk. There was no clinical history of poliomyelitis nor could any other abnormality be found. She was asked to re-attend the hospital but failed to do so.

The patient was first referred to me at the age of 12 years by her dental surgeon, who had noticed that she had facial asymmetry and an associated malocclusion.

As she walked into the surgery it was noticeable that she had a slightly abnormal gait and that she held her head inclined to the right side. She was a mature girl for her age but had a noticeably thin neck.

Clinical examination revealed a very slight weakness of the facial muscles on the left side and apparent complete absence of the left sternomastoid. The lip posture was competent. The skeletal pattern assessed clinically was a mild Class III and there appeared to be some skeletal asymmetry with the mandibular centre line shifting round to the left side. Intra-oral examination showed crowding in both arches with loss of space in the upper arch for the upper canines and in the lower arch for the lower second premolars. A Class III type of occlusion with a shift of the lower centre line by 1 unit to the left.

Radiographs revealed that all the permanent teeth were present and treatment is being confined to the treatment of the malocclusion.

An attempt was made radiographically to demonstrate the absence of the left sternomastoid muscle and to try and demonstrate any true skeletal asymmetry. This proved to be difficult and all that was really demonstrated was the shift of the lower centre line to the left and the slightly smaller mastoid process on the left side compared with that on the right.

Table I.—Comparison of Weights and Dimensions of Teeth on the Two Sides in the First Case

Tooth Weights

$\underline{\lvert 4}$	= 1·680 g.
$\underline{4\rvert}$	= 1·280 g.
$\overline{\lvert 4}$	= 1·390 g.
$\overline{4\rvert}$	= 1·200 g.

Tooth Measurements

		Length	*Breadth*	Difference between Left and Right Sides: *Length*	*Breadth*
$\underline{6\rvert}$	=	11·25 mm.	11·00 mm.	1·50 mm.	0·50 mm.
$\underline{\lvert 6}$	=	12·65 mm.	11·60 mm.		
$\underline{5\rvert}$	=	9·80 mm.	7·25 mm.	2·25 mm.	1·25 mm.
$\underline{\lvert 5}$	=	12·00 mm.	8·50 mm.		
$\underline{3\rvert}$	=	8·50 mm.	6·00 mm.	1·50 mm.	5·00 mm.
$\underline{\lvert 3}$	=	10·00 mm.	11·00 mm.		
$\underline{2\rvert}$	=	6·25 mm.		0·75 mm.	
$\underline{\lvert 2}$	=	7·00 mm.			
$\overline{6\rvert}$	=	12·00 mm.	11·50 mm.	0·25 mm.	0·50 mm.
$\overline{\lvert 6}$	=	12·25 mm.	12·00 mm.		
$\overline{4\rvert}$	=	8·50 mm.	8·25 mm.	2·00 mm.	0·75 mm.
$\overline{\lvert 4}$	=	10·50 mm.	9·00 mm.		
$\overline{3\rvert}$	=	7·50 mm.		0·75 mm.	
$\overline{\lvert 3}$	=	8·25 mm.			

I would suggest that the asymmetry in this case is associated with the absence of the left sternomastoid muscle and made more apparent by the slight facial weakness that is present. The true cause of the slight

wasting of her left leg and the slight flaccid weakness of this limb, together with the facial weakness, has not been explained. It could be that the cause was a mild attack of poliomyelitis but this would not explain the facial weakness and it is possible that the two pathologies are not in fact connected. The close relation of the facial nerve with the mastoid process may also be a factor in the mild facial weakness. The absence of the sternomastoid muscle has resulted in a faulty posture of the head which may account for the mandibular asymmetry.

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DISCUSSION

Mr. J. H. Gardiner asked whether any optical defects had also been discovered. He had been told by an eye surgeon that often the posture of a patient's head could be traceable to an eye defect.

Mr. E. S. Broadway, in reply, said that as far as he knew no optical defects had been discovered. Neither of the children wore glasses.

Dr. J. R. E. Mills said that his experience of condylar hypertrophy was very limited, but the two or three cases he had seen had progressed over a number of years—in adolescence and perhaps past puberty—and had then stopped. Had this been Mr. Broadway's experience?

Mr. E. S. Broadway, in reply, said that he did not think that cases of unilateral condylar hypertrophy necessarily stopped at the end of puberty. However, the number of cases was small and they were not usually allowed to progress far before something was done.

Mr. P. H. Burke said that in his case which Mr. Broadway had mentioned, the facial asymmetry had increased at puberty. One of the interesting things about Mr. Broadway's communication was that it was an example of variation in tooth size. Rushton had made the point that control of the tooth size was rigid—at least he thought it was. Lundström has found that there was asymmetrical variation. McCance, by starving pigs, had found that the size of teeth was reduced. So perhaps the control of tooth size was not as rigid as had been thought.

Would Mr. Broadway agree that there were some malocclusions which were baffling until tooth sizes were measured, particularly the lateral incisors, which showed greater variation in size than any other?

Mr. E. S. Broadway asked Mr. Burke if he believed that asymmetrical differences in tooth size were quite common.

Mr. P. H. Burke said they were commoner than orthodontists thought they were.

Mr. E. S. Broadway said that he agreed with that, but in the patient he had reported the difference in tooth size had been enormous, especially the canines, where the difference was half a centimetre.

The President (*Dr. W. J. Tulley*) said that Rushton had described a large number of asymmetries and mandibular hypertrophies due to trauma in the late teens.

THE EXTRACTION OF AN UPPER LATERAL INCISOR AS PART OF ORTHODONTIC TREATMENT

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ALTHOUGH the absence of the upper lateral incisor is not uncommon, its extraction, as the tooth of choice for orthodontic purposes, is rarely carried out.

The upper lateral incisor is the commonest tooth to be congenitally absent (with the exception of the third molars). It can be absent, abnormally small ('peg lateral'), or of any size up to almost upper central incisor proportions and these variations can occur in unilateral or bilateral combinations. Also the upper lateral incisor may suffer from a developmental anomaly, which ranges from that of invaginated odontome, in its most severe form, to the much more common ' cingulum pit '. An unfortunate sequel to this can be infection of the pulp leading to an apical infection and loss of the tooth. Another possible cause of loss of an upper lateral incisor would be as the result of a traumatic injury. Its very common absence in cleft palate patients is almost invariably treated by prosthetic replacement. In many of these cases with missing upper lateral incisors, circumstances (e.g., crowding) have resulted in the space closing (i.e., without resource to a prosthetic replacement) and the appearance of the upper canine against the upper central incisor is displeasing. This probably tends to influence the orthodontist into choosing teeth for extraction farther back in the mouth wherever possible.

CASE REPORTS

Case 1.—J.T., born June, 1945, first presented to the orthodontic department in January, 1956, when the following report was made:—

' Class III dental base relationship with a maxilla which is short anteroposteriorly. The arch is narrow which is possibly associated with a low tongue posture. The labial segment is crowded with the left upper buccal segment forward in relation to the labial segment. In the right buccal segment there has been early loss of $\underline{E}|$ with nearly a full unit loss of space. Early loss of $\overline{EDC|CDE}$ has resulted in some forward shift of the lower first permanent molars, greater on the right than the left. There is a degree of anterior open bite which might be the result of the high gonial angle and deep intermaxillary space anteriorly, or it might be associated with tip of tongue to lip contact during production of the anterior oral seal. Lips are slightly incompetent.' (*Figs.* 1, 2.)

In spite of the centre line shift to the left, the upper right buccal segment was still very crowded (with $\underline{5}|$ space completely lost), due to $\underline{6}|$ having rotated forward following the early loss of $\underline{E}|$. Therefore an extraction in addition to $\underline{5}|$ would be necessary to correct the centre line. The tendency to Class III occlusion with a reduced incisor overbite suggests the importance of maintaining buccal segment support of the maxillary labial segment. Hence, rather than the extraction of two teeth (in addition to the $\underline{5}|$), it was decided to extract only the $\underline{|2}$ and attempt to get the further space necessary for $\underline{2}|\underline{|3}$ alinement by distal movement of the buccal segments.

January, 1957: $\overline{6|6}$ were extracted—a decision largely influenced by the high caries rate.

December, 1959 (*Fig.* 3): $\underline{|2}$ was extracted and an upper removable appliance fitted to move $\underline{|3}$ into the line of the arch. The space in the lower arch resulting from the loss of $\overline{6|6}$ had closed on the right side, but $\overline{|5}$ was spaced some 2 mm. from $\overline{|4}$ at this time.

June, 1960: $\underline{6|6}$ were banded and a palatal arch with a whip, as described by Friel and McKeag (1939) was fitted to correct the rotation of $\underline{6}|$. This was carried out with two purposes in mind, namely (1) to gain space since the corrected $\underline{6}|$ would take up less space in the line of the arch, and (2) to facilitate later distal movement of the buccal segments.

February, 1961: $\underline{6}|$ rotation had been corrected, $\underline{2}|\underline{|3}$ were banded and a Johnson twin wire apparatus fitted. This was supported and, in fact, more space gained by use of extra-oral traction to $\underline{6|6}$. Also the insertion of the stopped labial arch into one of the two tubes on $\underline{6}|$ band prevented any initial tendency for relapse of $\underline{6}|$ rotation to occur.

November, 1961: Alinement of $\underline{2}|\underline{|3}$ had been obtained with, however, only the slightest degree of over-rotation of $\underline{2|1}$. The bands were removed and an upper removable retainer inserted. This was worn full time for some 5 months and then in bed only for a further 6 months.

Presented at the Country Meeting held in Plymouth on 22 May, 1964.

Fig. 1.—*Case* 1. Photographs of the patient before and after treatment.

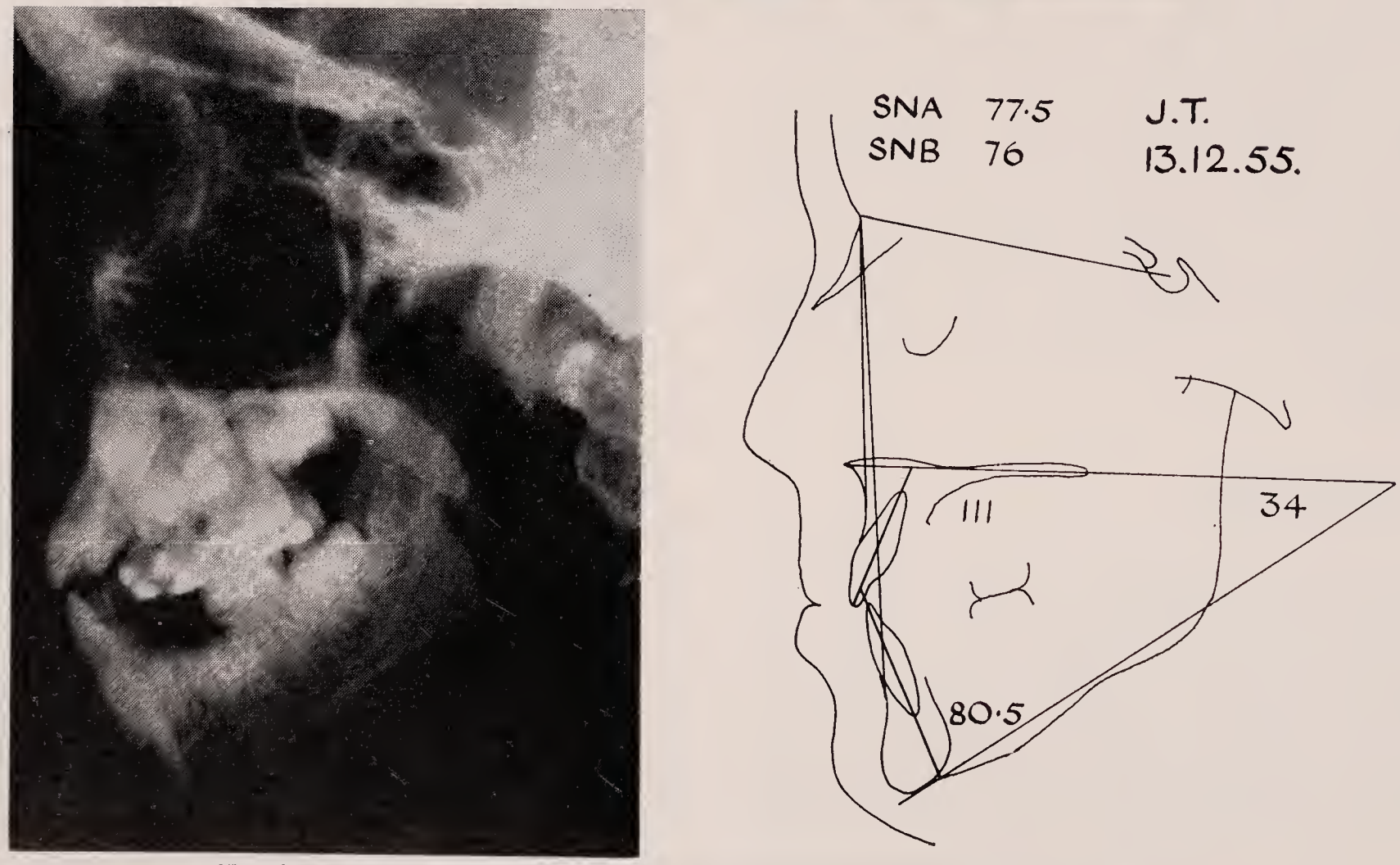


Fig. 2.—*Case* 1. Radiograph and tracing of the patient before treatment.

October, 1962 : $\frac{7|7}{}$ were extracted, the unerupted $\frac{8|8}{}$ being present in a satisfactory position radiographically.

November, 1962 : The upper removable retainer was discarded. Whilst it had been worn, some mesiopalatal relapse of $\frac{2|}{}$ had occurred. $\overline{|8}$ had begun to erupt.

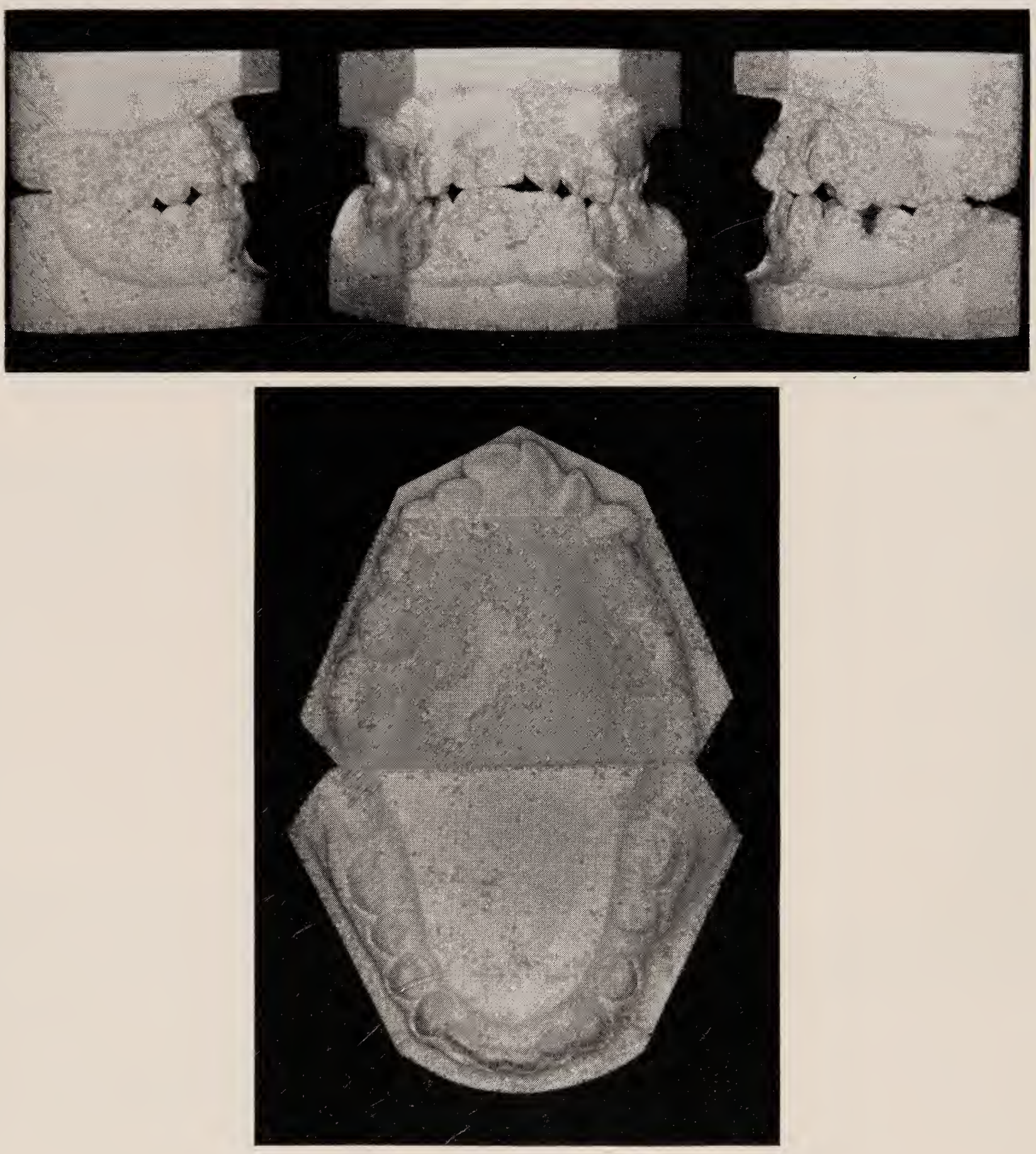


Fig. 3.—*Case* 1. Models of the patient before treatment.

November, 1963 : No further relapse had occurred. $\frac{5|}{}$ appeared radiographically to be coming down very slowly and in fact a bulge could be palpated palatally. The space between $\overline{45}$ had closed. (*Figs*. 4, 5.)

Case 2.—J.K., born May, 1950, first presented to the orthodontic department in January, 1960, when the following report was made:—

' Skeletal pattern is mild Class II. Teeth large on a moderate dental base area. All four buccal segments are forward in relation to the labial segments with considerable imbrication of upper and lower incisors. Even with the extraction of $\frac{4|4}{4|4}$ there will be inadequate space for alinement of remaining teeth and residual imbrication can be anticipated. It may even be necessary to extract $\frac{2|}{}$ instead of $\frac{4|}{}$, if alinement of the upper anterior teeth is to be achieved to an acceptable standard.' (*Figs*. 6, 7, 8.)

The position of $\frac{2|}{}$ was very poor with its apex palatally displaced. Although it would have been possible to move this tooth into alinement, it would have involved a protracted and difficult treatment with the possibility of partial relapse. Also the correction of the centre line shift would have presented further mechanical problems in that extraction of the $\frac{4}{}$ would have made available only just sufficient space

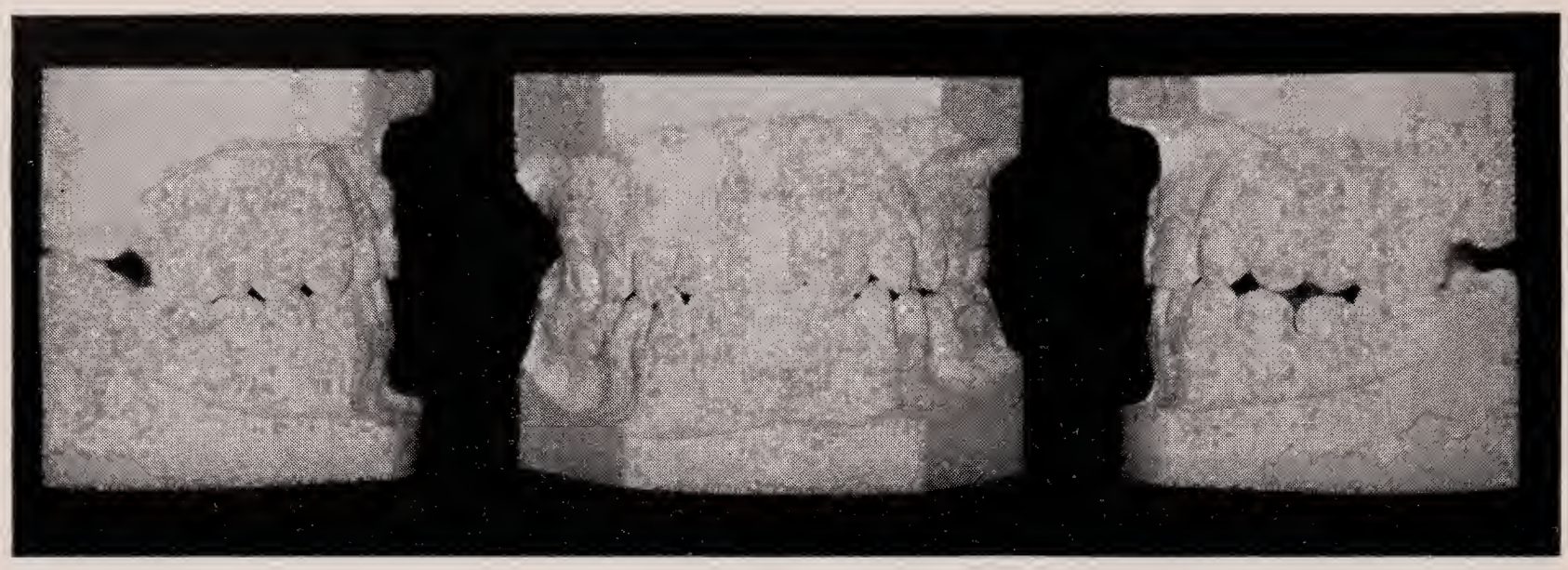


Fig. 4.—*Case* 1. Models of the patient after treatment.

in the left upper buccal segment (allowing none for anchorage shift), and the inclinations of $\underline{3|1}$ were slightly unfavourable for the tooth movements that would have been necessary.

February, 1960 : $\frac{|4}{4|4}$ were extracted and (1) an upper removable appliance fitted to retract $\underline{|3}$, and (2) lower multiband apparatus fitted and arches used to correct progressively the buccal displacement of $\overline{5|}$; improve the axial inclination of $\overline{1|1}$; adjust the vertical heights of the teeth; move $\overline{3|3}$ distally using compressed coils between $\overline{3-1|}$ and $\overline{|1-3}$ and finally aline $\overline{21|12}$. A spur was added to the mesial of $\overline{|1}$ band to facilitate correction of the rotation of this tooth.

July, 1960 : $\underline{2|}$ was extracted.

February, 1961 : Upper arch treatment was now complete, only removable appliances having been used. However, $\underline{|E}$ was still present and firm.

April, 1961: $\overline{65|56}$ bands were removed and a fixed sectional retainer fitted from $\overline{3-3}$.

May, 1961: $\underline{|E}$ was extracted. The $\underline{|5}$ appeared to be about to erupt mesial to it, a fact closely related to failure of a normal resorption pattern of the $\underline{|E}$ root.

February, 1962 : $\frac{7|}{7|7}$ were extracted. This decision was made in view of the fact that $\overline{7|7}$ had erupted buccally displaced and large lower third molars were present in reasonable position radiographically, both factors suggestive of the presence of residual crowding. $\underline{|7}$ was left at this time to encourage closure of the residual space in this buccal segment.

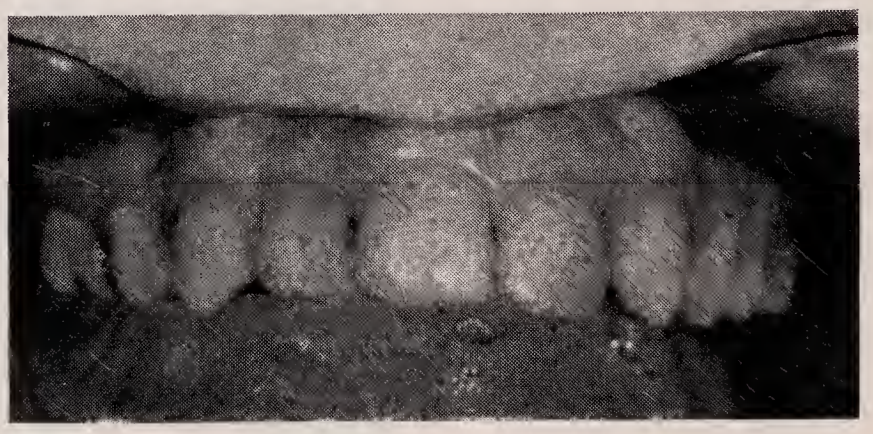


Fig. 5.—*Case* 1. Intra-oral photograph of the patient's upper anterior teeth.

March, 1962 : Lower sectional retainer was removed.

April, 1963 : The spacing in the upper left buccal segment had closed and $\underline{|7}$ was consequently extracted.

November, 1963 : (1) The unerupted $\frac{8|8}{8|8}$ had been moving through the alveolar bone. (2) The lower intercanine width had further reduced. (*Figs.* 9, 10.)

POINTS OF INTEREST ARISING FROM THE LINE OF TREATMENT USED

1. The Influence of the Caries Rate on the Treatment Plan

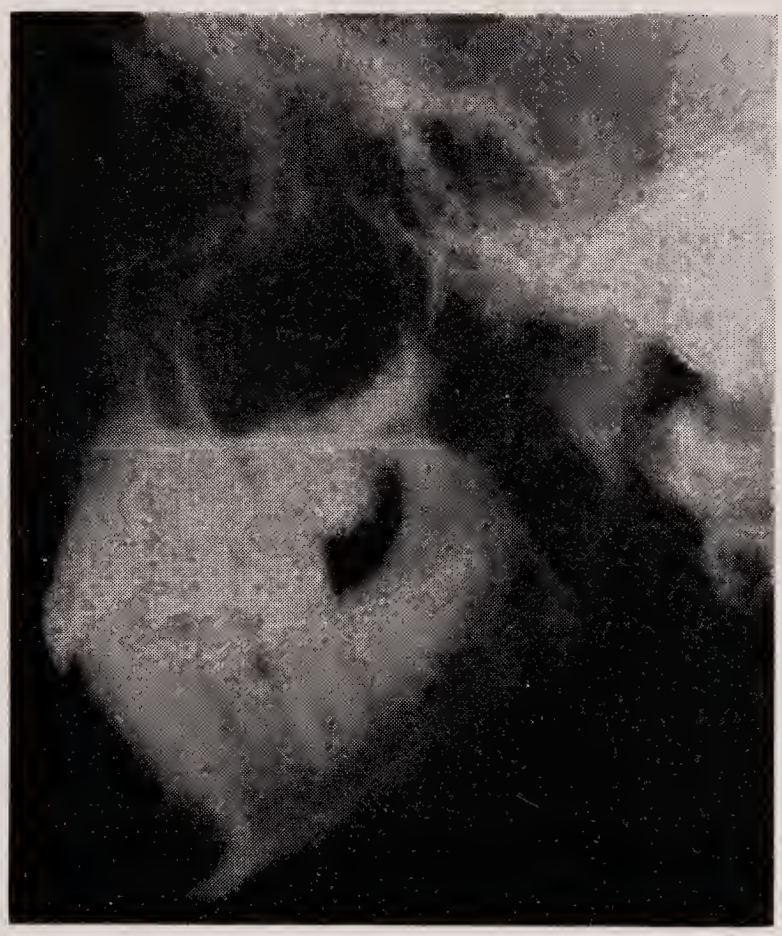
Excessive caries (e.g., as demonstrated by lower anterior interstitial cavities) tends to suggest the simplest treatment possible. However, in J.T. the treatment proved to be complicated and somewhat prolonged to achieve an acceptable result. The fact that her caries experience had not noticeably worsened over this period, may well have been associated with her good oral hygiene and the controlling effect of regular conservative care.

Fig. 6.—*Case* 2. Models of the patient before treatment.

Fig. 7.—*Case* 2. Photographs of the patient before and after treatment.

2. The Rotation of an Upper First Permanent Molar

Before distal movement of upper buccal segments is attempted, obvious cuspal interferences, such as rotated upper first permanent molars, are best corrected.



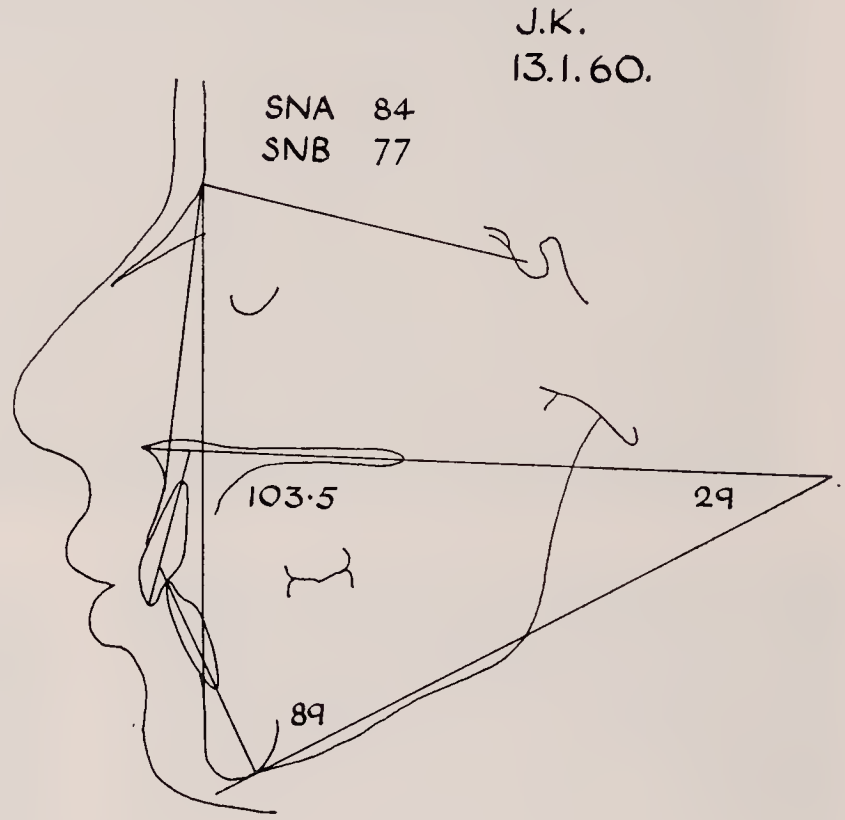
A

C

The right upper first permanent molar of J.T. was not only rotated mesiopalatally but was lying palatally to the line of the arch. To correct its buccopalatal position, the tube was attached as far distally on the band as practical. It is possible that an acceptable result would have been achieved had I used extra-oral traction with a terminal hinged section to $\underline{6}|$ instead of the labiolingual rotator.

3. Relapse of Treated Rotated Anterior Teeth

Over-correction seemed to be the treatment of choice. Then, after the apparently inevitable partial relapse, reasonable alinement may result. However, varying factors may make this difficult (e.g., occlusion) and the duration of retention is still rather empirical.



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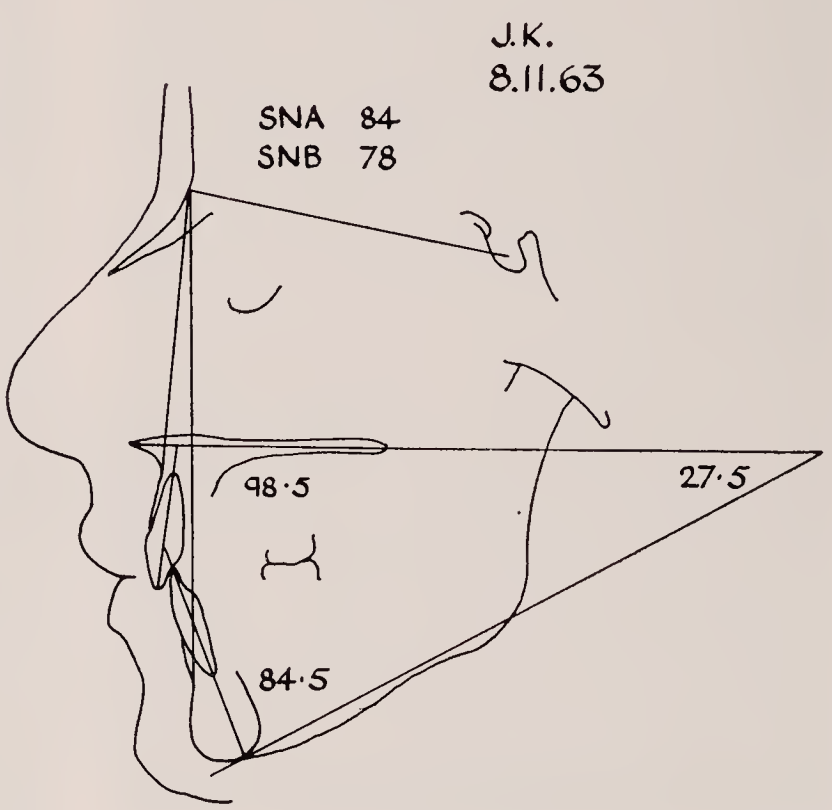

D

Fig. 8.—*Case* 2. A, Radiograph, and B, tracing of the patient before treatment. C, Radiograph and D, tracing after treatment.

Fig. 9.—*Case* 2. Models of the patient after treatment.

4. Lower Intercanine Width

It is easy to expand the lower intercanine width when using multiband to retract these teeth, and care must be taken to prevent this by design of the arch wire. This is particularly important when crowding has resulted in the $\overline{3|3}$ being buccally displayed initially. Fortunately, in J.K. slight residual spacing distal to $\overline{3|3}$ was present. This would appear to have allowed the $\overline{3|3}$ to collapse lingually without reciprocal incisor relapse occurring.

5. Extraction of $\overline{7|7}$

The decision to extract $\overline{7|7}$ is often a very debatable one, as eruption of $\overline{8|8}$ into a good position is uncertain (Smith, 1957). This is rarely true in the upper arch. Results from examination of a large series of case histories where $\overline{7|7}$ have been removed is long awaited, so that similar decisions can be made with more certainty in the future. The degree of residual crowding, with the fear of its effect on incisor relapse, prompted their extraction in this case (J.K.) and eruption of $\overline{8|8}$ is awaited with some trepidation.

OBSERVATIONS

If special reasons are present to indicate choosing an upper lateral incisor for extraction, the adjacent teeth should be closely examined for certain features which may serve to improve the appearance of the final result. Firstly, the upper canine from the point of view of its inclination. Ideally, this tooth should be upright or distally

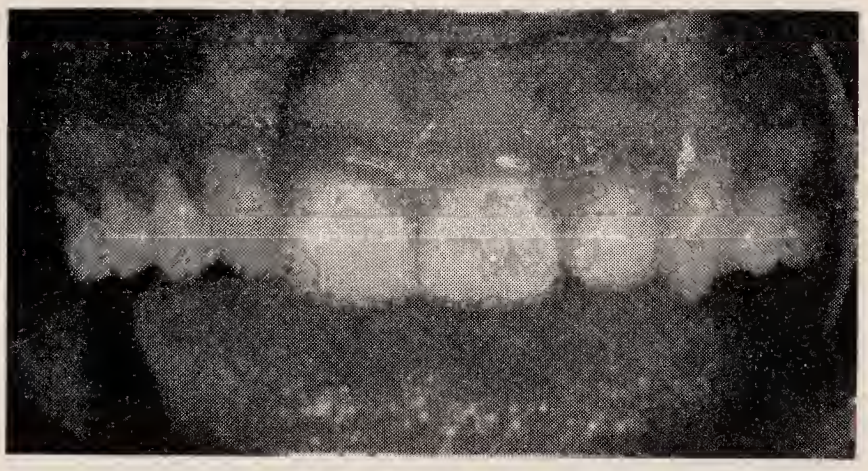

Fig. 10.—*Case* 2. Intra-oral photograph of the patient's upper anterior teeth

inclined (i.e., apex mesially placed) to ensure contact with the upper central incisor without opening of what would be, aesthetically, an unsightly space. Also the labial face of the canine should ideally be flattish and the crown not too pointed so that it may reasonably simulate the upper lateral incisor. Secondly, the upper first premolar of the same side should be rotated

mesiopalatally slightly (J.K.) or have a short palatal cusp (by grinding, if necessary). In either case, this cusp will not show and the tooth will simulate the upper canine.

Both of these patients presented with a marked shift of the upper centre line. Instead of correcting this irregularity, the upper lateral incisor was extracted on the side to which the centre line was deviated. This, of course, did nothing to improve the centre line shift and in fact tended to perpetuate it. However, people are surprisingly unobservant in this matter and there can be no doubt that the choice of extraction both greatly simplified and shortened treatment time. I therefore believe that these two case histories serve to illustrate that acceptable results can be achieved by the somewhat drastic step of extracting an upper lateral incisor on the rare occasions where this decision is taken.

Acknowledgements

I should like to thank Mr. S. G. McCallin and Mr. G. G. T. Fletcher for their permission to publish these cases; and the Photographic Department of the Eastman Dental Hospital for preparing the photographs and slides.

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DISCUSSION

Mr. E. S. Broadway asked the author to follow the cases up until the third molars had erupted and report the result when they had.

Mr. V. S. Iyer said that he was surprised that Mr. Broadway had not remarked on the second case dealt with by Mr. Brenchley. This showed quite an asymmetry. On the right side in the incisor region there was a great deal of crowding. That was probably why Mr. Brenchley had selected the upper incisor, to get more space in the anterior region. He wondered if Mr. Broadway would care to comment on the asymmetry.

Mr. E. S. Broadway said that he had noticed that there was some asymmetry but thought that it was probably within normal limits.

Mr. B. S. Cryer asked how much asymmetry of the centre line Mr. Brenchley would accept before trying to correct it? He had been following a number of cases in which lower second molars had been removed, and his impression was that Mr. Brenchley need not worry about $\overline{8|8}$.

Mr. M. L. Brenchley, in reply, said that what was an acceptable shift in the centre line depended very much on other things, such as in this case the very poor position of a lateral incisor. In cases where the centre line had shifted but the teeth could be alined, it was obviously better to try to correct the centre line.

Mr. L. H. Russell pointed out that Mr. Brenchley had extracted lower second molars. The X-rays showed that the third molar was already mesially inclined and it was unlikely that it would ever achieve the true position.

Mr. M. L. Brenchley, in reply, stressed that his decision was debatable, to say the least, The reason for his decision was the fear of relapse of the lower incisors. The ideal position of the third molars, if second molars were to be extracted, was very slightly mesially tilted in the normal developmental position. The earlier they were extracted—from twelve onwards —the better.

Mr. L. H. Russell said that he could not agree. Professor Killey was very emphatic that, even if there was only the slightest mesial title in the third molar, it was likely to get worse, not better.

Mr. B. S. Cryer said that in the cases he had followed it had been noted that, where the axis of the developing third molar at the time of extraction of the second was up to 45 degrees to the long axis of the second molar, a reasonable occlusion of the third molar could be expected in a fair proportion of cases. He agreed with the author that early extraction was recommended.

Mr. R. E. Rix endorsed what Mr. Cryer had said. If lower second molars were extracted early and if the third molar had a mesial tilt of up to 45 degrees, a very good final position of the third molar would be attained in relation to the first. Their axes would be almost parallel.

Mr. V. S. Iyer was surprised that Mr. Brenchley was prepared to accept a slight midline shift of the upper arch but not slight crowding of the lower incisors. He would have thought that crowding of the lower incisors was more prevalent in nature than a midline shift.

Mr. M. L. Brenchley said that orthodontics was always a compromise.

Mr. E. J. R. Bird disagreed with Mr. Brenchley about the centre line and the attitude of patients. He had had a recent case in which the centre line got shifted over during treatment. The patient's parent pointed it out. The patient had been an older girl. Younger children possibly did not notice it, but perhaps it was more noticeable when they were older.

Mr. W. Nicol said that what patients noticed about centre line shifts was where there was a tilt of the teeth to the side of the shift. This was often accompanied by a slope of the occlusal plane. If a centre line had shifted but the teeth had remained upright, it was often quite acceptable and not noticed.

AN APPLIANCE FOR THE ROTATION OF UPPER MOLARS

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ROTATION OF MAXILLARY MOLARS

This is a problem commonly met with in orthodontic practice. The maxillary first permanent molar usually rotates mesiopalatally if it drifts mesially following early loss of deciduous cheek teeth. The maxillary second permanent molar often shows a similar rotation when it has moved forwards following loss of the first molar. It would seem that the large straight palatal root is resistant to migration and acts as a rotational axis, about which drifting occurs. The greater variation found in the root formation of maxillary second molars with varying degrees of root fusion and more slender root form, possibly accounts for the tendency to the less marked rotation usually seen in maxillary second molars. Lesser degrees of rotation of maxillary first permanent molars may result from their eruption into crowded upper arches and rarely, secondarily, to tilted lower first permanent molars (following early loss in the lower arch).

METHODS OF TREATMENT

Orthodontic correction of these rotations is not easy and fixed appliances are necessary. The choice is really one of two types of appliance differing basically in their mode of action.

Type 1

Appliances that can be activated to apply a rotational force to the molar concerned, e.g., (1) The labiolingual rotator as described by Friel and McKeag (1939); (2) By activation of the free-end of a bow being used with extra-oral traction or intermaxillary elastics. This has the complication in unilateral use of theoretically having some reciprocal action on the contralateral molar (tending to move it distally and rotate it mesiobuccally).

Type 2

An appliance which, while moving the molar distally, allows it to rotate freely. Such an appliance is used in an attempt to reverse the process which produced the rotation and, therefore, its success is presumably dependent on the effect of the palatal root as described above.

DESIGN OF APPLIANCE

The labial arch for use with extra-oral traction can be modified for this purpose. This consists of a 1-mm. labial arch, stopped by U-loops which enable the anteroposterior length to be adjusted, with its free ends fitting into 1-mm. tubes attached to the buccal surface of bands on the molars to be moved. It is activated by traction from a neck strap or headcap transmitted through arms or ' whiskers ' (1·25-mm. stainless steel wire) which are fixed anteriorly to the arch. Instead of the rigid free-ends of the arch fitting into the tubes on the molar bands, the end can be made to rotate freely. Such an appliance using traction from an extra-oral source was described by Ronning (1962). The method he advocated of attaching the terminal hinged section to the stopped labial arch is by means of a labial coil of 0·016 in. stainless steel wire with 3–5 loops and long legs welded to each part of the arch. The hinged section and its method of attachment which I am about to describe has, I believe, certain advantages, namely:—

1. It is simple to construct.
2. It has a very strong construction.
3. It hinges freely, but with only a limited arc of rotation (limitation is necessary to facilitate insertion).
4. Owing to its simple form and minimal bulk, the possibility of it impinging on the soft tissues is no greater than for the unmodified extra-oral traction bow.
5. It can be preformed.

CONSTRUCTION OF APPLIANCE

The method of construction can be seen from the diagrams. A short length of 1-mm. hard stainless steel wire is attached to 1-mm. hard

A demonstration presented at the Country Meeting held in Plymouth on 22 May, 1964.

stainless steel tubing, as shown (*Fig.* 1A). If a thin strip of stainless steel tape (e.g., 0·08 × 1·5 mm.) is pulled round them, welded, and then solderflushed over this, optimum union is achieved. The wire is then bent at right-angles, and cut off short (5 mm.). The end of the tubing level with this right-angled bend is bevelled to about 45° facing away from the wire, and the excess tubing cut off (to leave the hinged section about 4 mm. in height) (*Fig.* 1B). This completes the hinged section, and it can be readily attached to a 1-mm. arch specially prepared by having the U-loop some 6 mm. mesial to the molar to be rotated. The arch is turned up at right-angles at the appropriate point just mesial to the molar tube; the hinged section is dropped over it, as shown, and the end of the arch is then cinched forwards and cut off short (*Fig.* 1C). This turning forward of the arch end must be done quite firmly as, in conjunction with the bevel, it limits the arc of rotation of the hinge.

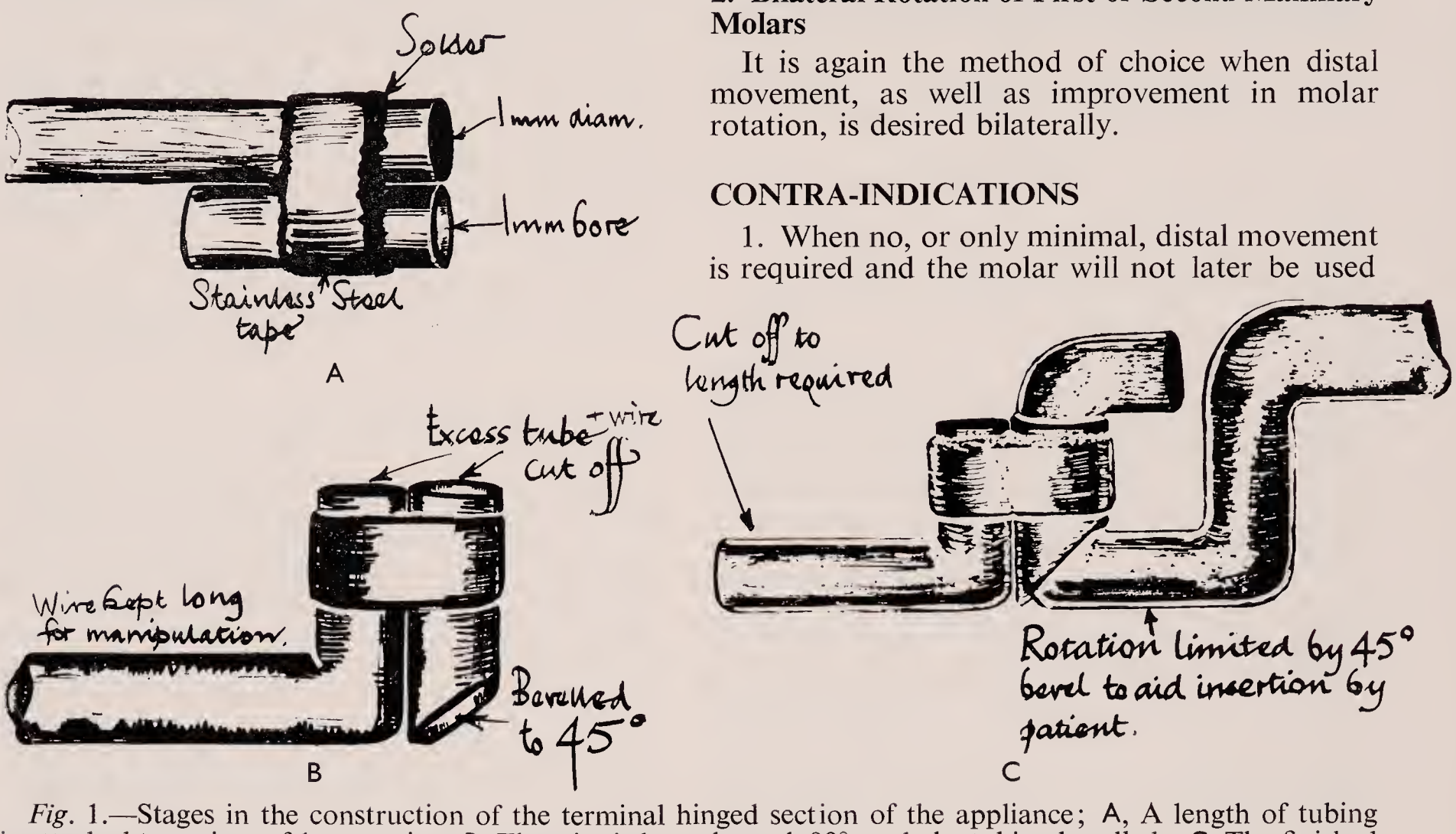

Fig. 1.—Stages in the construction of the terminal hinged section of the appliance; A, A length of tubing is attached to a piece of 1-mm. wire. B, The wire is bent through 90°, and the tubing bevelled. C, The finished attachment.

INDICATION FOR USE

1. Rotation of a Single Maxillary Molar

It is the method of choice whenever distal movement of the molar is also desired (in excess of that possible to gain by rotation around a tube placed palatally on the molar band) and some distal movement of the contralateral molar is also advantageous. The rotated molar, being usually farther forward, can be expected to show more distal movement under similar orthodontic forces than does the contralateral molar. (All other factors being similar, the amount of distal movement is likely to be related directly to the space available in the dental arch posterior to the molar.)

2. Bilateral Rotation of First or Second Maxillary Molars

It is again the method of choice when distal movement, as well as improvement in molar rotation, is desired bilaterally.

CONTRA-INDICATIONS

1. When no, or only minimal, distal movement is required and the molar will not later be used as a source of anchorage for complicated tooth movements.
2. When a marked degree of rotation and/or expansion without excessive distal movement is required.
3. When the patient's co-operation is suspect, either in wearing the appliance for about 14 out of every 24 hours or in the possession of adequate manual dexterity to manipulate the appliance (particularly the bilateral version).

CLINICAL POINTS

The limited arc of rotation of the hinged section makes it possible for a patient of average co-operation and manual dexterity to insert the appliance even when used bilaterally. However, there is much to be said for initially fitting an unmodified extra-oral traction bow and allowing the patient to become accustomed to its manipulation. If this is not readily accomplished before the next visit, it may be well to reconsider using this type of appliance at all. By having the U-loop placed some 6 mm. to the mesial of the molar to be rotated, and placing some form

of friction stop during this initial period, the hinged section can be added readily to the same arch at the second visit. The only disadvantage of this approach is that the insertion of the straight arch necessitates that the tube attached to the molar band is more to the distal of the buccal surface than the modified arch requires. It is possible that the tube position may then have to be altered as rotation correction proceeds satisfactorily.

Acknowledgements

I should like to thank Mr. Potter of the Photographic Department of the Eastman Dental Hospital for the illustrations.

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THE DEMONSTRATION OF EMBRYONIC AND ADULT BONE USING A SOLID RESIN EMBEDDING TECHNIQUE

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W. R. BURSTON, Ph.D., D.Orth. R.C.S., L.D.S.

L. F. GORE, F.I.M.L.T.

University of Liverpool

THE routine alizarin methods used for the demonstration of embryonic and adult bone utilize glycerin or methyl salicylate for the final mounting of cleared and stained specimens (Culling, 1963). These specimens are delicate and therefore are more usefully mounted in a resin which will enable them to be observed, handled, and photographed without damage (*Figs.* 1, 2).

The following technique has been used for this purpose.

TECHNIQUE

Stage I

Specimen fixed in 10 per cent buffered formol–saline. Carefully dissect away the skin and as much soft tissue as possible without damaging the bone. Wash for 24 hours in running water. Bleach in the following solution for about one week: 10 parts 20 vol. hydrogen peroxide to 90 parts 70 per cent ethanol.

Stage II

Macerate the specimen in changes of 4 per cent potassium hydroxide (small specimens are less likely to be disrupted if 2 per cent potassium hydroxide is used). Excess soft tissue and opaque fat may be easily removed during this stage. The time taken for complete maceration varies with the size and maturity of the tissue and may be several weeks.

Stage III

Stain in 2 per cent potassium hydroxide to which is added, drop by drop, sufficient of a saturated alcoholic solution of alizarin red S. to turn the solution to a deep red: allow to remain in this solution until the bones are completely stained. Wash for 24 hours in tap water. If adequately macerated little staining of tissue takes place; however, any excess stain will be removed during washing and subsequent dehydration.

A demonstration presented at the Country Meeting held in Plymouth on 22 May, 1964.

Stage IV

Dehydrate carefully through daily changes of ascending grades of alcohol to absolute alcohol and then two changes of acetone.

Fig. 1.—A 24-week foetus embedded in a bakelite block 8·5 × 5·0 × 3·0 cm.

Stage V

Transfer directly from acetone into the following polyester resin mixture in a polythene box:—

Polyester resin (Bakelite S.R. 19098*)	100 ml.
Catalyst	0·5 ml.
Accelerator	0·5 ml.

Specimen should be completely immersed with at least a $\frac{1}{2}$-in. covering of resin. Leave undisturbed on a cool bench to slowly polymerize—this should take about 48 hours.

Note: It is of advantage to have previously polymerized a layer of plastic in the embedding box on which to lay the specimen.

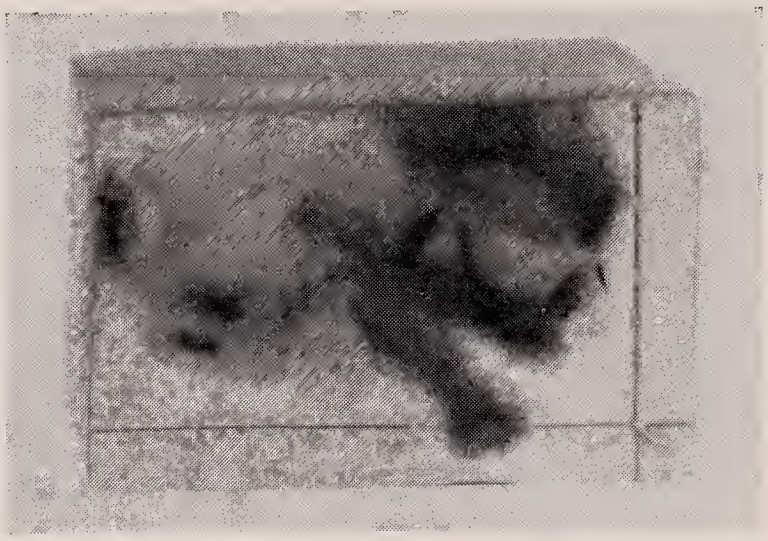

Fig. 2.—A 12-week foetus embedded in a bakelite block 2·5 × 1·9 × 1·7 cm.

Stage VI

When completely hardened the block may be trimmed on a band saw and polished using a linisher belt, fine-grade abrasive papers, and polishing buffs.

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* Obtainable from Bakelite Ltd., Manchester.

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A STUDY OF SOME CONVENTIONAL AND UNCONVENTIONAL ORTHODONTIC SCREWS WITH SOME PRACTICAL RECOMMENDATIONS CONCERNING THEIR USE

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INTRODUCTION

In a previous paper (Haynes and Jackson, 1962) the mechanics and efficiency of 21 different orthodontic screws were investigated, and recommendations made concerning their practical use. The results of this work showed that screws of the basic Fischer design were more acceptable than those of the basic Badcock and Hausser types and that Hawley Russell 666 and 999 and Wipla 629 provided the most suitable combinations of stable traverse and low bulk for use in removable orthodontic appliances.

Eleven other screws, some of unconventional design, have recently been investigated, but owing to the expense of some and lack of availability of others, only one of each type has been studied. These screws are now described and the findings are of interest since they demonstrate wide variations in mechanical properties and technique.

The screws considered are classified into unconventional and conventional groups and the data for each screw was obtained in the manner previously described. The results, however, may not represent the standard screw type in each case, owing to the intrinsic variations between similar screws and for this reason comparison with screws previously studied is not strictly possible.

The screws examined were as follows:—

1. Unconventional Screws

a. Lomberg

i Single Hinge
ii Double Hinge
iii Class III

b. Nord

i Non-telescopic, small, medium, and large
ii Telescopic, medium and large

Table I.—Data Pertaining to Lomberg Hinge Screws No. 1 and 2 and Class III Screws.

Type	Stable		Maximum		Distance Qtr.-turn (mm.)	Efficiency (per cent)	Overall Dimensions				Recommended Rate of Turning	Period of Effective use
	Trav. (mm.)	Turns	Trav. (mm.)	Turns			Length (mm.)	Width (mm.)	Thickness (mm.)	Volume (c.mm.)		
Hinge 1	4·0	21	7·9	38	0·2	51	12·5	5·1	3·0	191	1 x wk.	21 wk.
Hinge 2	6·6	33	7·4	38	0·2	89	15·0	8·7	5·7	744	1 x wk.	38 wk.
							Screw					
Class III	5·2	23	6·7	31	0·2	76	16·0	10·0	3·6	554	1 x wk.	23 wk.
							Extension					
							26.5	6.6	3.5	609		
							Total volume			1163		

A demonstration presented at the Country Meeting held in Plymouth on 22 May, 1964.

c. Svenska Dental Instruments
Spring Screw (Landin)

d. Orthodontic Laboratories, Melbourne
Orthoteknic (Heath) Screw

2. Conventional Screws
a. Dentaurum
i Spring Tension 101 A
ii Spring Tension 101 B

b. Rocky Mountain Products
Spring Tension A 601

1. Unconventional Screws
a. Lomberg Screw
i. Single hinge (*Table I, Fig.* 1)

There are two separate components to this screw, namely a flat hinged section which is incorporated into the posterior margin of each segment of the appliance, and an expansion screw unit which joins the segments anteriorly. When in use, the hinge restricts separation of the two halves of the appliance posteriorly, whilst activation of the screw causes arch expansion anteriorly. On examination of an experimental appliance, the change produced in intercanine width was 5·6 mm. whilst inter-first molar width increased by only 0·3 mm. Coincident with this, the separation of the segments in the lateral incisor region was increased by 6·2 mm. From the data in *Table I* it can be seen that this screw is of low bulk (191 c.mm. excluding the hinge which is of negligible volume). The stable and absolute traverse are 4·0 mm. (21 quarter-turns) and 7·9 mm. (38 quarter-turns) respectively and consequently the efficiency index is of a low order (51 per cent). The rate of expansion per quarter-turn is 0·2 mm. and therefore it is advised that the screw is activated once weekly for a maximum period of 21 weeks. *Fig.* 2 demonstrates a single hinge screw appliance and llustrates the change produced upon activation.

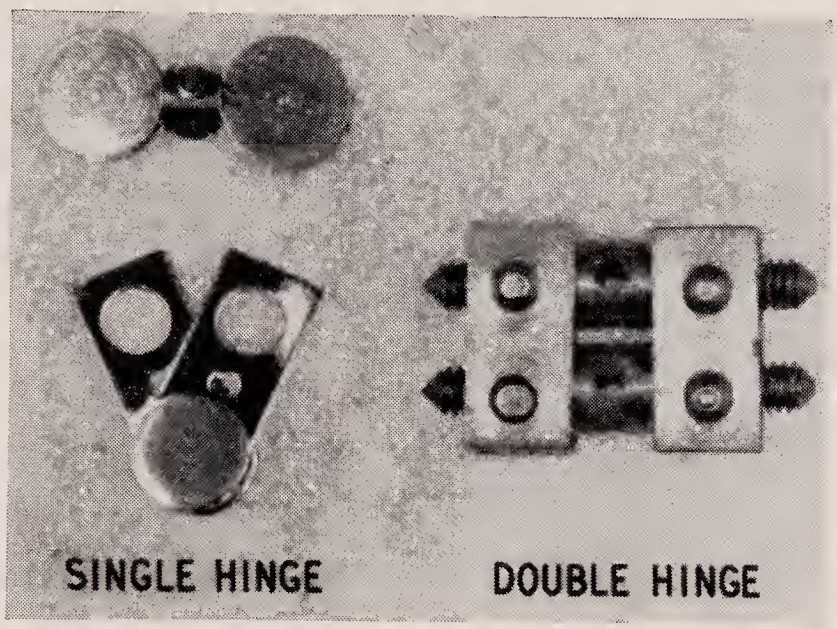

Fig. 1.—Lomberg hinge expansion screws.

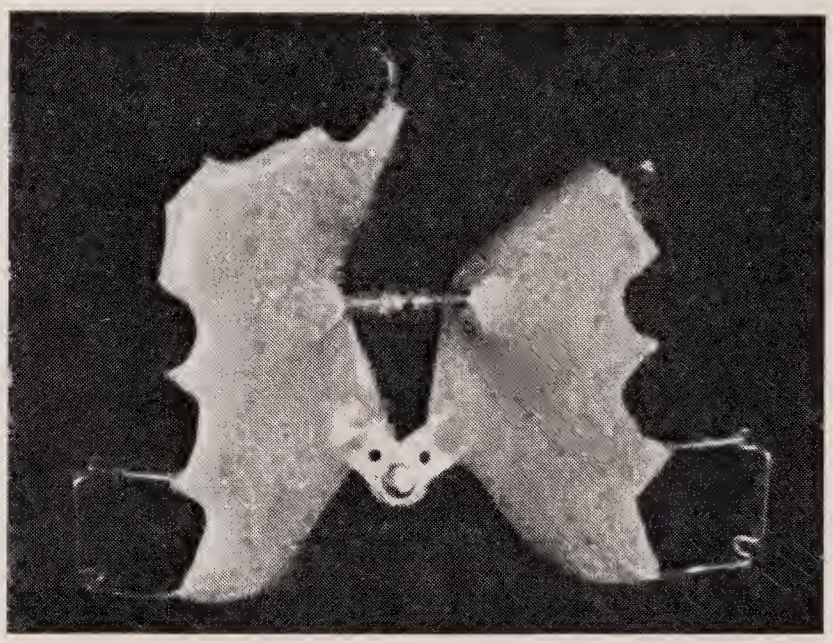

Fig. 2.—Lomberg single hinge expansion screw, demonstrating differential movement obtained by activation.

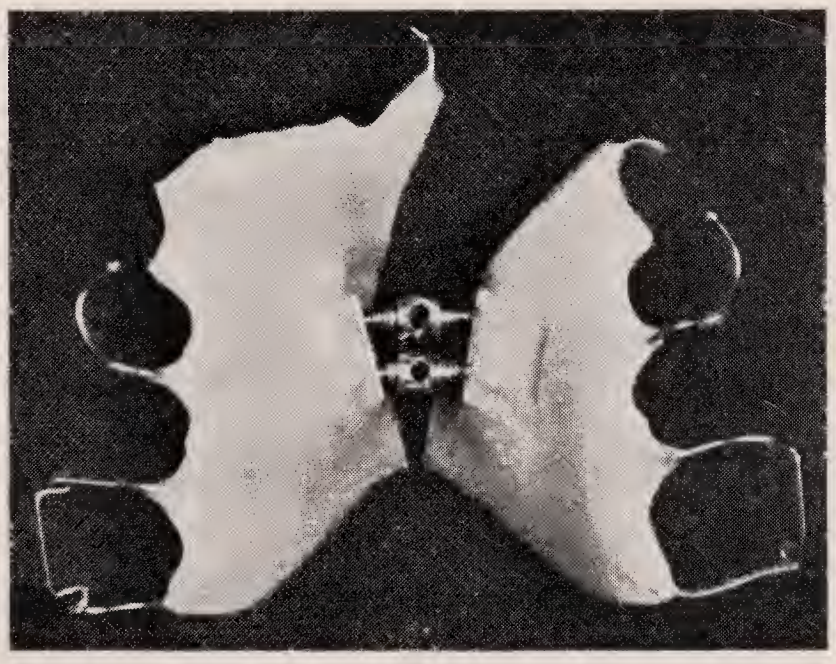

Fig. 3.—Lomberg double hinge screw activated to show differential movement produced.

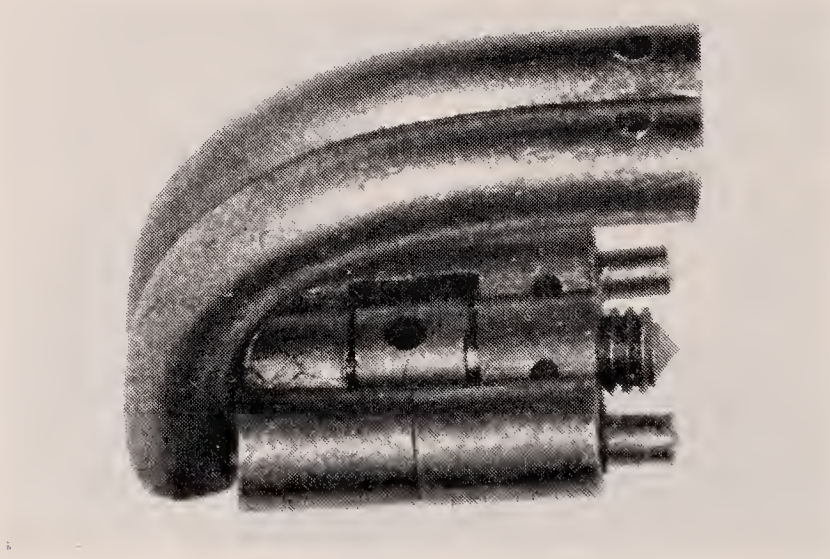

Fig. 4.—Lomberg Class III screw.

ii. Double hinge (*Table I, Fig.* 1)

This design of screw is also intended to produce a differential rate of expansion at different points across the arch. It consists of two parallel screw spindles mounted in a housing of twice the usual size. Variation in anteroposterior arch width

(hinge expansion) is produced by turning the screws at different rates. Conversely, parallel expansion may be obtained by turning the screws simultaneously. In practice, however, the double screw mechanism first strips the thread and then fractures the anterior spindle after a certain traverse is 6·7 mm. (31 quarter-turns) and the movement per quarter-turn is 0·2 mm., efficiency is 76 per cent and a turning rate of once weekly (for a maximum of 23 weeks) is indicated. *Fig.* 5 shows the change in incisor relationship produced by activation of the screw but unfortunately

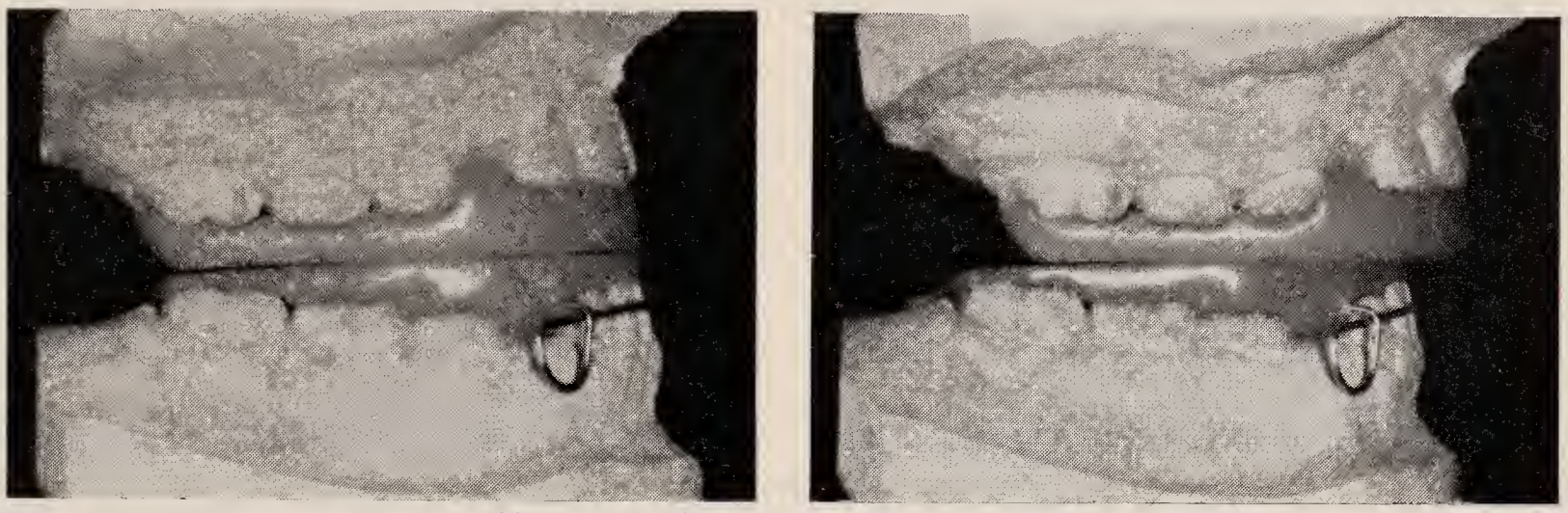

Fig. 5.—Change produced by activating Class III screw.

degree of use. This weakness was seen in one experimental appliance in which the anterior spindle was turned twice for each turn of the posterior one. Breakage occurred after 18 quarter-turns of the anterior spindle. At this point, however, the intercanine dimension had increased by 4·8 mm. whilst the intermolar width had changed by only 0·6 mm. Simultaneously there was a separation of the segments by 6·5 mm. in the lateral incisor region. The dimensions of this screw are shown in *Table I*, together with other data; it is not abnormally long or wide, but has great bulk (744 c.mm.) owing to its excessive thickness (5·7 mm.). Parallel expansion permits a stable traverse of 6·6 mm. (33 quarter-turns) and an absolute traverse of 7·4 mm. (38 quarter-turns). These values give an efficiency of 89 per cent and a movement of approximately 0·2 mm. per quarter-turn. Thus the recommended rate of turning is once weekly and the effective period of clinical use is 38 weeks. An appliance incorporating this screw is illustrated in *Fig.* 3. The basic weakness of this screw was stripping and subsequent fracture of the anterior spindle. This feature was not noticed in the single hinge screw even when extended to the limit of stable traverse, i.e., 21 turns.

iii. Class III screw (*Table I, Fig.* 4)

This screw is designed specifically for incorporation into the Class III (reverse) Andresen appliance. It consists of a Lomberg No. 3 screw which has a curved rigid bar extension attached to one end. The screw is positioned with its free end against the palatal aspect of the upper central incisors, and the end of the curved extension lingual to the lower incisors.

On analysis (*Table I*) the screw is seen to be of extremely large bulk (1163 c.mm.), with a stable traverse of 5·2 mm. (23 quarter-turns). Maximum

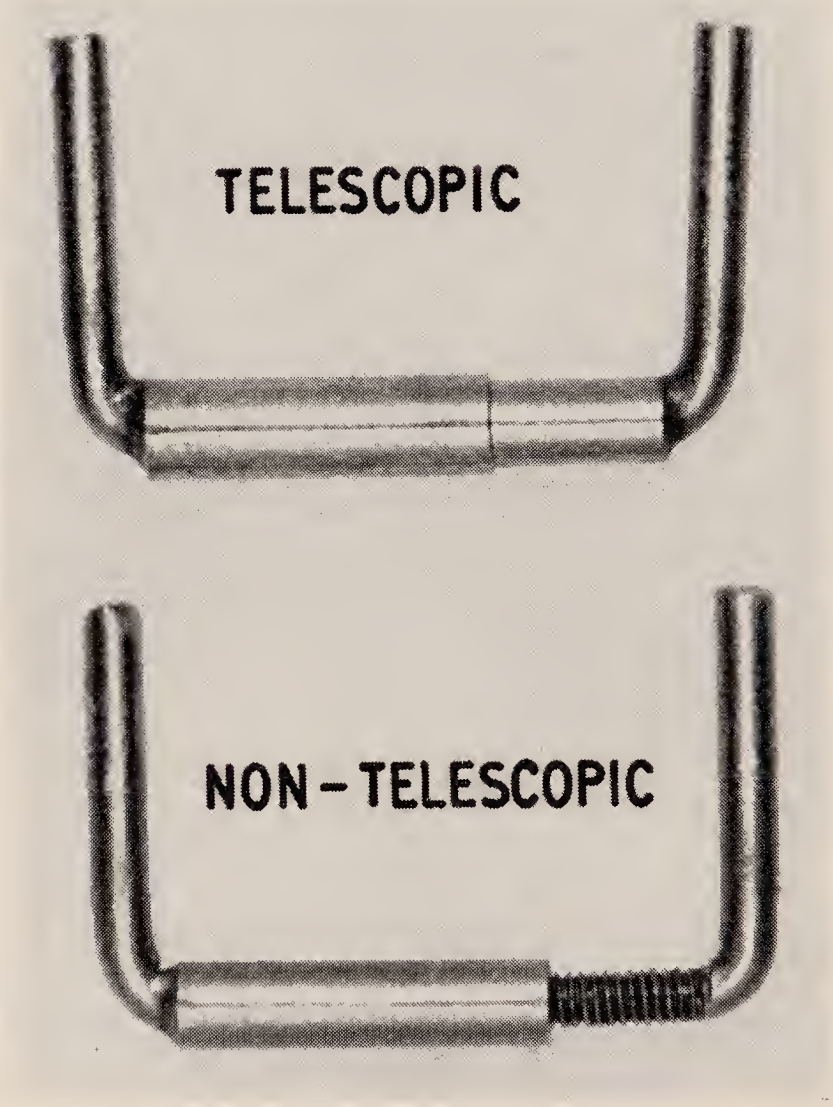

Fig. 6.—Nord expansion screws.

the appliance is unsuitable for routine use in Class III cases.

b. Nord Screws (*Table II, Fig.* 6)

Although first used in 1919, these screws have only recently been introduced into the United Kingdom. They are available in two different designs, non-telescopic and telescopic. The non-telescopic type is manufactured in three sizes and the telescopic in two. The non-telescopic

screw consists of a tapped barrel and threaded spindle, each of which is extended to form a retention arm at right angles to the screw portion. The telescopic screw is similar but has an additional sleeve attached concentrically round the spindle, hence the barrel is supported both internally and externally in this design. The Nord screw is designed specifically for bilateral expansion of the arch, and cannot be used for such a wide variety of tooth movements as is possible with those of the basic Fischer type.

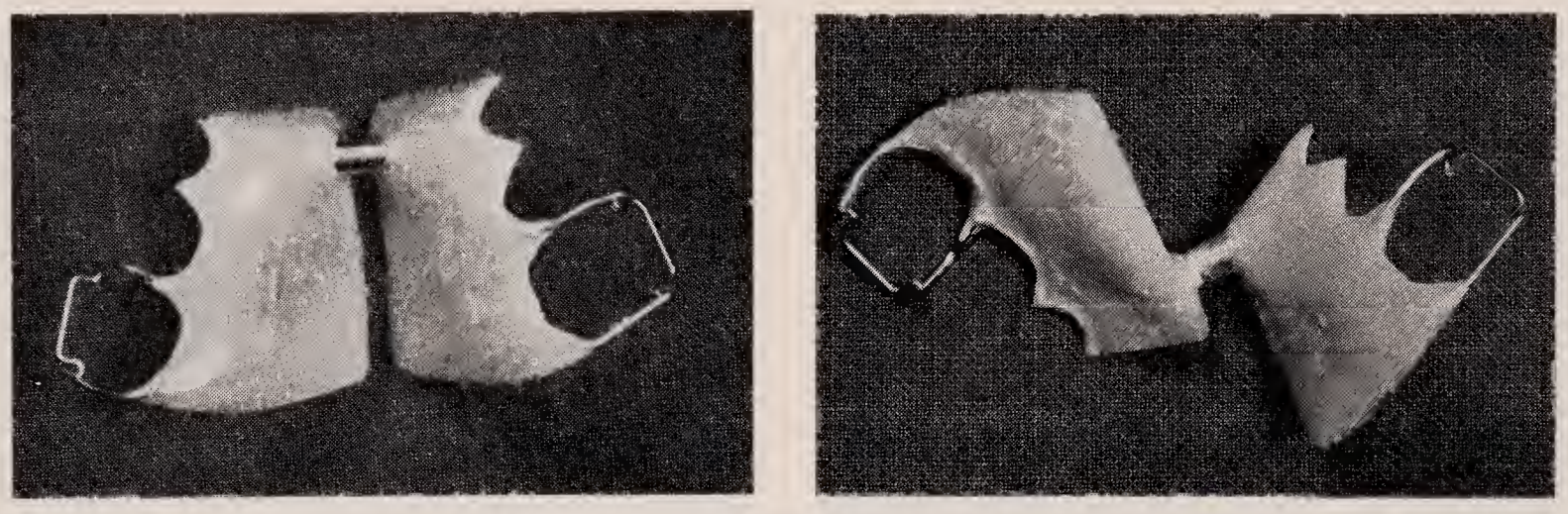

Fig. 7.—Nord expansion appliance and method of activation.

When incorporating the Nord screw into the appliance, it is positioned symmetrically in the palate of the upper arch or lingual sulcus of the lower, and the mid section of the screw barrel is left uncovered by wax. A key is not required for its activation, this being effected by rotating one of the segments through one complete revolution (*Fig.* 7).

i. Analysis of non-telescopic types (*Table II*)

On analysis of the small, medium, and large screws of this type, it is seen that the stable traverse is 6·5 mm., 6·8 mm., and 7·1 mm., respectively, and that the corresponding number of revolutions required to achieve these distances is 17, 18, and 17. Maximum traverse is 7·0 mm., 9·0 mm., and 9·9 mm., and the number of possible activations are 18, 23, and 25, respectively. Efficiency (92 per cent, 79 per cent, and 71 per cent) decreases as the size of screw increases, and the bulk of each screw is in the region of 200 c.mm.

ii. Analysis of telescopic types (*Table II*)

The values for stable and maximum traverse are the same (6·3 mm.) for the medium screw but differ for the large size, i.e., 7·0 mm. and 7·7 mm., respectively. Sixteen full revolutions are required to achieve stable traverse in the medium screw and 19 in the large. Efficiency values are 100 per cent and 90 per cent respectively and the bulk of each type is approximately 250 c.mm.

The movement per activation in both telescopic and non-telescopic types is 0·4 mm. This figure is double the amount seen in Fischer

Table II.—Data Pertaining to Nord Screws

Type of Screw	Stable		Maximum		Distance Per Turn (mm.)	Efficiency (per cent)	Period of Effective Use	Overall Measurements				*Total Volume* (c.mm.)
								Length		*Diameter*		
	Trav. (mm.)	Turns	Trav. (mm.)	Turns				Screw (mm.)	Retention Tags (mm.)	Screw (mm.)	Retention Tags (mm.)	
Non-telescopic												
Small	6·5	17	7·0	18	0·39	92	34 wk.	15·3	14·0	3·0	2·0	196
Medium	6·8	18	9·0	23	0·39	79	36 wk.	16·0	14·0	3·0	2·0	201
Large	7·1	17	9·9	25	0·39	71	34 wk.	17·7	14·0	3·0	2·0	213
Telescopic												
Medium	6·3	16	6·3	16	0·39	100	32 wk.	15·3	14·0	3·5	2·0	235
Large	7·0	17	7·7	19	0·40	90	34 wk.	17·0	14·0	3·5	2·0	261

All screws activated at rate of one revolution per two-weekly interval.

type screws, and together with the method of adjustment reflects an inherent weakness in design. However, as the Nord expansion appliances are only semi-rigid and distribute their force to the entire arch, this high rate of expansion per turn is seemingly tolerated by the tissues, but obviously the rate of turning should not exceed once per two-weekly interval in all cases.

c. Svenska Dental Instruments Spring Screw (Landin) (Table III, Fig. 8)

This screw is designed for buccal or labial movement of individual teeth. It consists of a

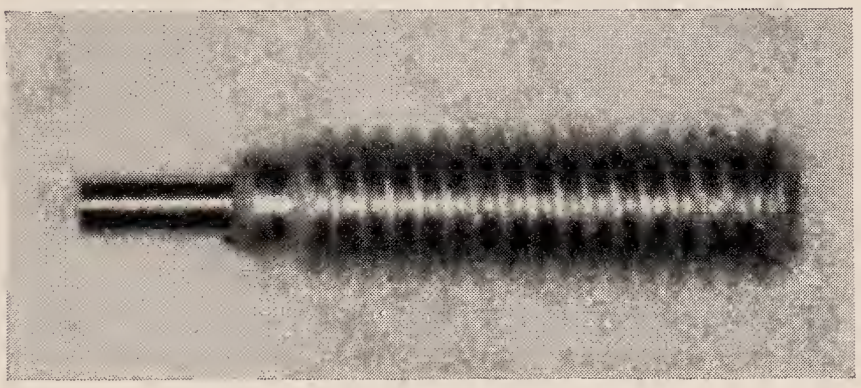

Fig. 8.—Svenska spring screw.

threaded spindle which is partially drilled out internally to receive a spring loaded rod. The screw may be incorporated into the appliance either before or after processing and pressure on the tooth to be moved is maintained by turning the screw and compressing the spring. Stability of this type of screw is determined by the length of screw housed in the base plate, and also by the resistance of this to wear. *Table III* shows the data obtained on analysis, from which it is seen that the stable traverse is 4·7 mm. (10 full revolutions), and the absolute traverse is 7·1 mm. (16 full revolutions). Efficiency is relatively low (66 per cent) and the distance moved per revolution is 0·44 mm. This is a high value especially as there is no visual guide for adjustments of 90°, but the inclusion of a spring makes this clinically acceptable. The volume of this screw (62·5 c.mm.) is less than that of any other examined, hence it is a useful means of proclining incisors and canines in cases where minimum appliance bulk is essential. Activation at the rate of 1 revolution every 2 weeks is recommended and it is also advisable that this be carried out by the dental surgeon. *Fig.* 9 shows the Svenska screw as used for the labial movement of an upper canine.

Fig. 9.—Svenska screw applied to lingually occluding upper canine.

Table III.—Data Pertaining to Orthoteknic (Heath) Screw and Svenska Instrument Screw

Type	Stable		Maximum		Distance Per Turn (mm.)	Efficiency (per cent)	Rate of Activation	Period of Effective Use	Overall Dimensions		
	Trav. (mm.)	Turns	Trav. (mm.)	Turns					Length (mm.)	Diameter (mm.)	Volume (c.mm.)
Svenska Dental Instrument Spring Screw	4·7	10*	7·1	16*	0·44	66	1 x 2 wk.	20 wk.	11·7	2·6	62·5
Dental Laboratories, Melbourne Orthoteknic (Heath)	8·8	121*	14·5	266*	0·054	60	1 x 2 d.	34 wk.	Housing 16·4	3·2	128
									Screw and Tag 16·8	1·3	22

Volume of Heath screw calculated with screw extended to limit of stable traverse plus 8 mm. allowance for retention tag.

Two screws required in practice ∴ total screw volume = 300 c.mm.

* Figures relate to complete revolutions for spring screw and quarter-turns for Orthoteknic screw.

d. Orthodontic Laboratories, Melbourne. Orthoteknic (Heath) Screw. (*Table III, Fig.* 10)

The clinical application of this screw has been described by Heath (1958) and Gould (1962), the appliances in which they are used being known as X-plates. The screw consists of a length of finely threaded wire (1·3 mm. diameter) and a tapered nut or housing. Each appliance requires two screws, which for the reduction of excessive overjet are initially unscrewed by a distance equal to the amount of tooth movement required. Thus the segments of the appliance are at first separated by the exposed thread, but undergo approximation as the nuts are turned.

The data relative to this screw are shown in *Table III.* Stable traverse is 8·8 mm. (121 quarter-turns) and absolute traverse is 14·5 mm. (266 quarter-turns). Efficiency is 60 per cent and the movement per quarter-turn is 0·054 mm. Hence a turning rate of once every two days is indicated. The volume of the screw (150 c.mm.), as shown in *Table III*, is calculated from the length of stable traverse (8·8 mm.) together with an allowance of 8 mm. for retention of the screw in the base plate. As two screws are used in practice the total bulk is 300 c.mm., thus this screw compares favourably with others possessing a similar range of action. There is no doubt that the Heath screw is a useful adjunct to the treatment of certain malocclusions in which only minimum supervision is possible. An appliance to retract the maxillary labial segment is shown in *Fig.* 11.

Fig. 10.—Heath Orthoteknic screw.

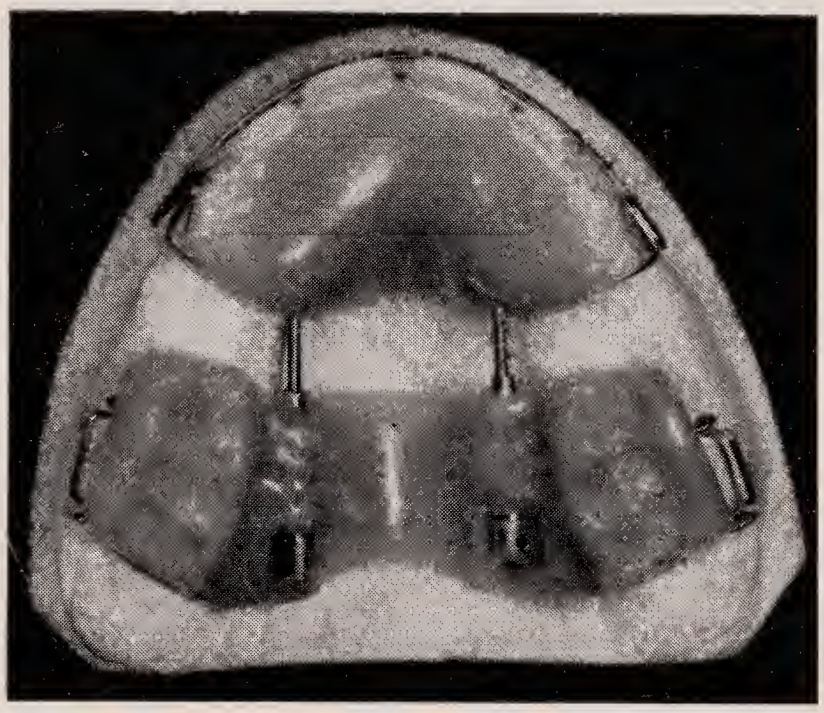

Fig. 11.—Heath X-plate designed to retract labial segment in Class II, division 1 case.

2. Conventional Screws

Dentaurum 101 *A*, 101 *B*, *Rocky Mountain Products A* 601 (*Table IV*, *Fig.* 12)

These screws have been grouped together as they are all of the Hausser spring tension type, the data from analysis being shown in *Table IV.* This shows that Dentaurum 101 B has the least stable traverse and 101 A the most (3·6 mm. and 4·7 mm., respectively). Maximum traverse ranges from 4·4 mm. (101 B) to 6·6 mm. (101 A). The most efficient screw is Rocky Mountain Products

Table IV.—Data Pertaining to Dentaurum Spring Tension Screws 101 A and 101 B and Rocky Mountain Products Spring Tension Screw A 601

Type	Stable		Maximum		Distance Qtr.-turn (mm.)	Efficiency (per cent)	Overall Dimensions				Rate of Activation	Period of Effective use
	Trav. (mm.)	Turns	Trav. (mm.)	Turns			Length (mm.)	Width (mm.)	Thickness (mm.)	Volume (c.mm.)		
Dentaurum												
101 A	4·7	31	6·6	41	0·16	71	14·0	8·5	4·4	524	1 x wk.	31 wk.
101 B	3·6	20	4·4	28	0·16	83	10·7	8·3	3·4	302	1 x wk.	20 wk.
R. M. P.												
A 601	4·5	20	5·0	28	0·18	94	11·3	8·6	4·2	408	1 x wk.	20 wk.

A 601 (94 per cent) and the least efficient is Dentaurum 101 A (71 per cent). The volumes vary from 302 c.mm. (101 B) to 524 c.mm. (A 601), and the movement per quarter-turn is 0·16 mm. in the case of the Dentaurum screws

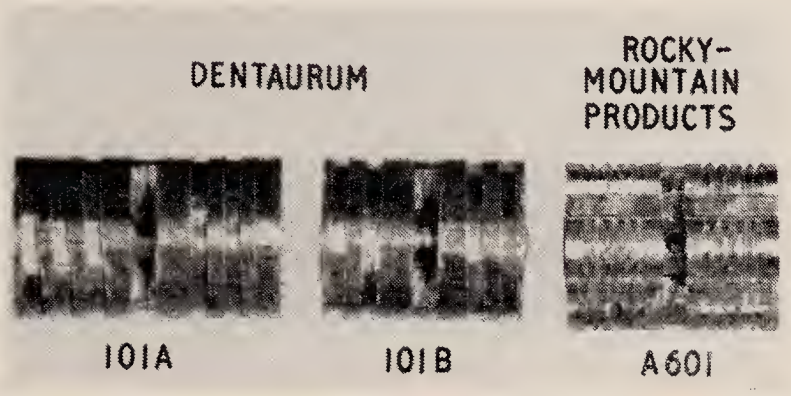

Fig. 12.—Dentaurum screws 101A, 101B and Rocky Mountain products A601.

and 0·18 mm. for the Rocky Mountain type, hence the advised rate of turning is once weekly for each screw type. Correlation of stable traverse to volume shows these screws to have similar characteristics to other spring tension screws previously studied, i.e., a relatively high bulk in proportion to the stable traverse obtained.

DISCUSSION

The object of this investigation and that reported previously (Haynes and Jackson, 1962) has been to differentiate between the wide variety of orthodontic screws which are now available, and to give practical recommendations concerning their selection and use. Many of these are of limited value in contemporary orthodontic practice, particularly the Lomberg Class III and Nord screws. The Lomberg Class III is only suitable for Class III treatments in which both upper and lower incisor angulations require alteration. Such instances, however, are uncommon, and the stability of the result following this method of treatment is not absolute.

The Nord screw permits a simple method of producing lateral arch expansion, but its mechanical characteristics are inferior to those of the more rigid screws previously described.

Lomberg hinge expansion screws are designed for use in cleft palate orthodontics. The single hinge type is superior to the double hinge screw, it being smaller in dimension, more efficient in design, and simpler to incorporate into the appliance.

The Svenska Dental Instrument spring screw (Landin) is a useful means of proclining individual teeth, particularly in narrow maxillary arches. In practice, however, the screw is of low efficiency and possesses a movement of 0·4 mm. per revolution, also it is unwise to allow the patient to activate this screw because there are no guiding limits and subjective use could lead to either inadequate or excessive activation.

The Orthoteknic (Heath) screw is useful for the treatment of superior protrusion, particularly if frequent supervision of the treatment is not possible. The laboratory technique, however, requires considerable expertise to fabricate a satisfactory appliance.

SUMMARY

The physical characteristics of some orthodontic screws manufactured by Lomberg, Svenska Dental Instruments, Orthodontic Laboratories (Melbourne), Dentaurum, and Rocky Mountain Products have been investigated and described. The findings demonstrate a wide range of stable traverse, efficiency, bulk, and degree of movement per activation. The results obtained have enabled a specific rate of turning to be recommended for each screw considered. Three of those examined are of particular value in widely different circumstances:—

1. The Lomberg single hinge type, which is a useful addition in the field of cleft palate orthodontics. It is of low bulk, simple to operate, and stable for a period of 20 weeks.

2. The Svenska Dental Instrument spring screw which, although only suitable for the movement of single teeth, is ideal for situations in which a spring cannot be positioned accurately.

3. The Heath Orthoteknic screw is of particular value in orthodontic treatment which cannot be supervised frequently by reason of limited travelling facilities or economic factors. This screw possesses a stable traverse of 8 mm. and is of relatively low bulk for a screw of this range.

Acknowledgements

The author would like to express his appreciation to Miss Angela Cooper for clerical assistance and to Messrs. J. Whitworth and D. Page for their technical services and construction of the appliances described. Thanks are also due to Mr. L. Jepson, A.I.B.P., A.I.S.T., and Mr. H. Grayson Lumby, M.S.I.A., N.D.D., for providing the illustrations, and to Dr. D. Jackson for valuable advice and criticism in the preparation of this paper. In addition, many of the screws were provided by Messrs. F. and H. Baxter, and their courteous co-operation at all times is acknowledged.

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FUNCTIONAL APPLIANCE THERAPY

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THE system of functional appliance therapy was introduced in 1924 by Andresen who modified Kingsley's bite plane and Robin's monobloc. This appliance activates the muscles of mastication and acts as an effective form of intermaxillary traction. When the activator was introduced on the Continent it was at first rejected, but later some of its most vigorous opponents realized the value of this form of therapy and became its staunch supporters. The introduction of the activator into this country was received at first with reserve, but, later, it became fashionable and was used indiscriminately in cases which did not warrant this type of treatment, and then fell into disuse because of the high failure rate. The demonstration showed some of the types of cases that respond to functional appliance therapy and some of these cases are described below.

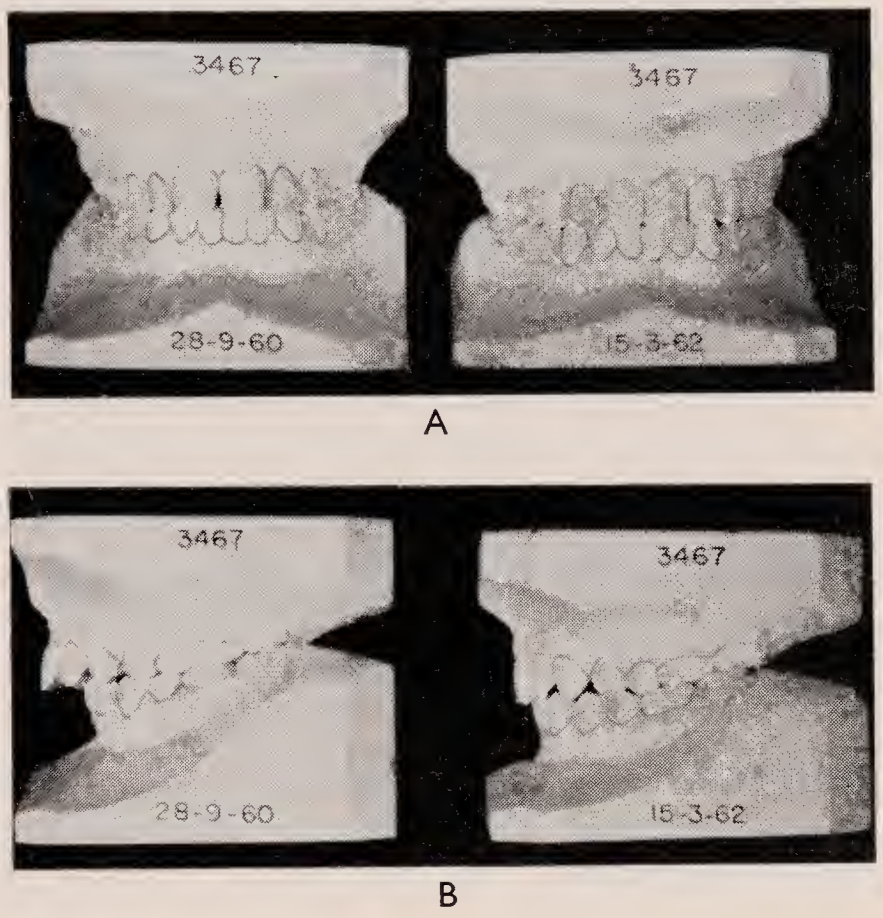


Fig. 1.—*Case* S.D. showing A, Anterior view of models; B, Left lateral view; C, Superimposed radiographs.

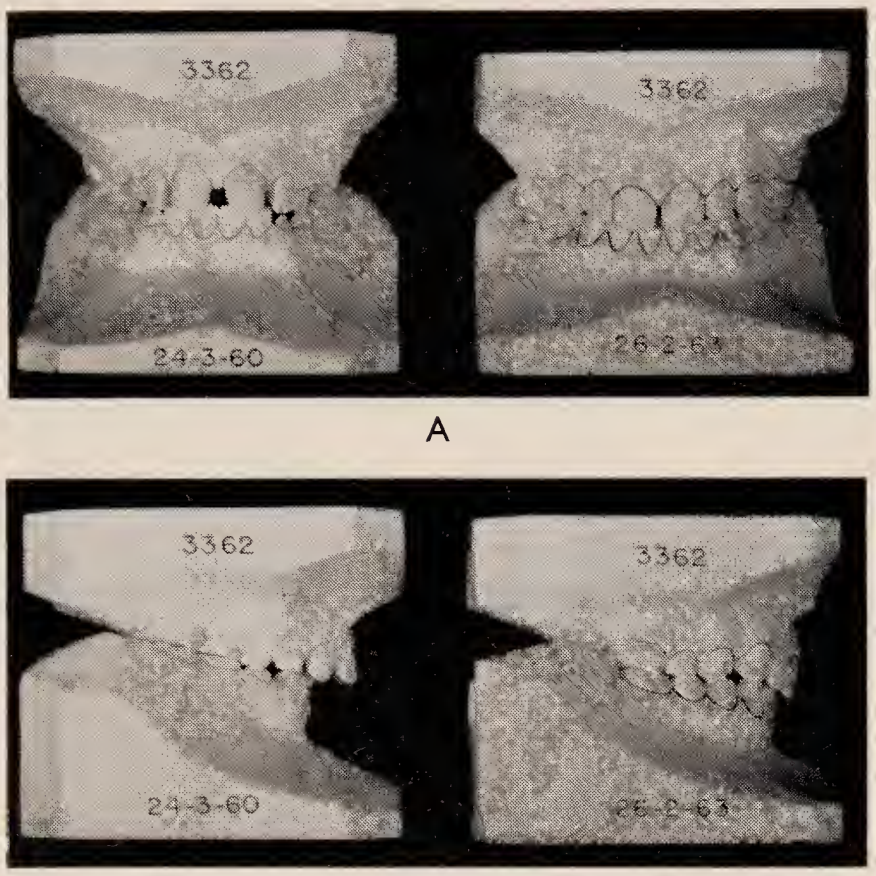
CLASS II, DIVISION 1

Several cases treated solely by activators in both mixed and permanent dentitions were shown. Many cases, however, cannot be treated solely with an activator and in these cases it is used in conjunction with other forms of appliance therapy. This was illustrated by the *Case* S.D. (*Fig.* 1). In this case an upper expansion retraction plate was inserted prior to treatment with an activator because there was a narrow intercanine width and as forward movement of the lower dental arch is only gradual, a stage would have been reached when the narrow intercanine width of the upper arch prevented the forward movement of the lower arch. The final study models show the case at the completion of treatment with a normal relationship of the dental arches.

It has been said that the success of the activator is due to a forward posturing of the mandible and that following completion of treatment, the case relapses, as the patient is merely posturing forward. Cases were shown which had been out of retention for three years without any change in the position of the teeth, and also *Case* S.L. (*Fig.* 2) was shown with the electromyographic records (*Fig.* 3) to show that the muscle patterns precluded a forward postural position of the

A demonstration presented at the Country Meeting held in Plymouth on 22 May, 1964.

mandible, giving an apparently satisfactory result. *Fig.* 3A shows the habitual bite of the patient prior to treatment, and it will be seen that the posterior temporal muscles show an increased



activity and also contract before the other muscles shown in the record. There is also a little anterior masseter activity and this is an indication that the patient has a distal relationship of the dental arch in occlusion. In order to ascertain whether the small activity of the anterior masseter muscle was due to faulty positioning of the electrodes, the patient was asked to protrude the mandible forward, and in *Fig.* 3B it will be seen that the anterior masseter muscle is now active and that there is no activity of the posterior temporal muscle. This indicates that the electrodes were in their correct position. *Fig.* 3C shows the habitual bite of the patient following treatment, with a normal pattern of activity in all muscles. Rakosi (1960, 1963) has pointed out that in his experience the cases that respond well to functional appliance therapy are those which have a distal displacement of the mandible prior to treatment. In a small series of cases treated in the Orthodontic Department, University College Hospital Dental School, which has had an electromyographic analysis there seems to be a strong correlation between the distal displacement of the mandible and a short treatment time. This case bears out this point and also illustrates that the distal position of the mandible before treatment is present, although the occlusion is apparently not indicative of a distal relationship.

CLASS II, DIVISION 2

Functional appliance therapy is suitable for Class II, division 2 cases provided the child is treated at an early age. Cases were shown which have been treated in conjunction with removable appliance therapy and some which have been treated solely with an activator using gutta

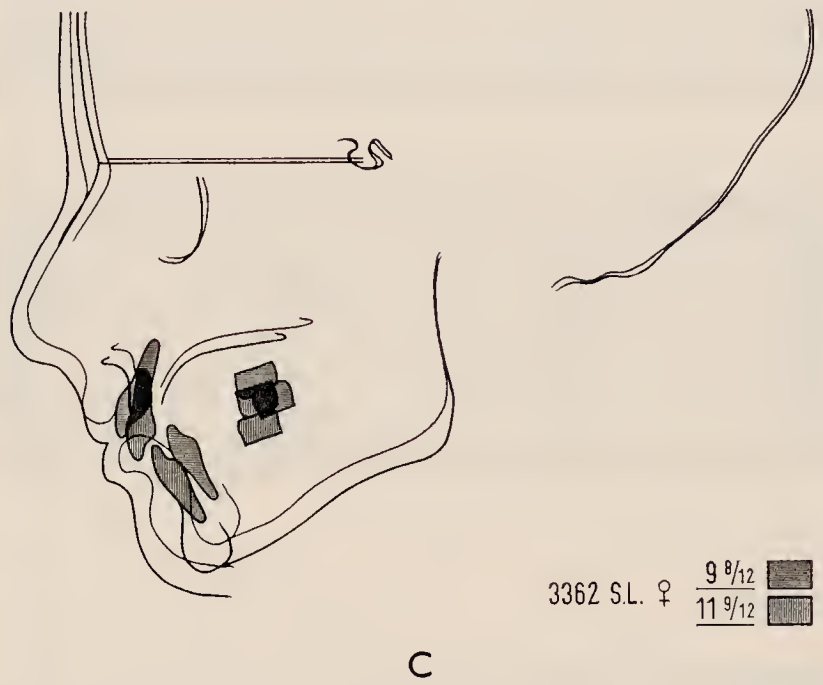


Fig. 2.—*Case* S.L. showing A, Anterior view of models; B, Right lateral view; C, Superimposed radiographs.

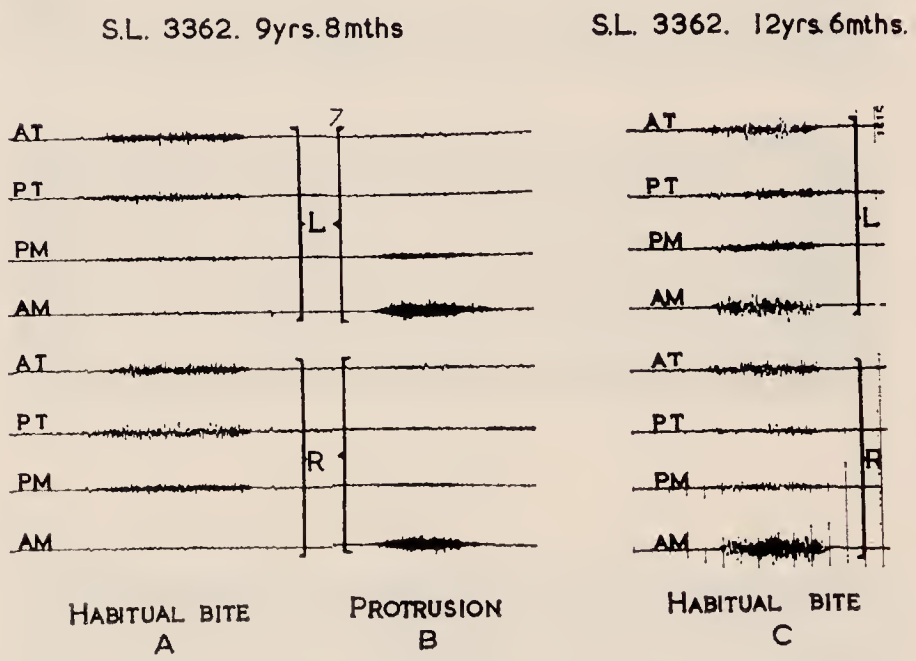


Fig. 3.—*Case* S.L. showing electromyographic recordings.

percha or guiding wires to procline the upper incisors to allow the lower dental arch to move forward. *Case* K.M-P. (*Fig.* 4) illustrates the use of an activator in a Class II, division 2 case. An upper appliance was first fitted to procline the upper incisors and then this was followed by the insertion of an activator. The final model shows the occlusion at 11 years of age with a normal relationship of the dental arches and an improved overbite. The problem of relapse in Class II, division 2 cases is one with which orthodontists are familiar, and, therefore, the long-term results of treatment must be known.

Case H.J. (*Fig.* 5) illustrates the results of treatment several years out of retention. The figure shows the models before and after treatment

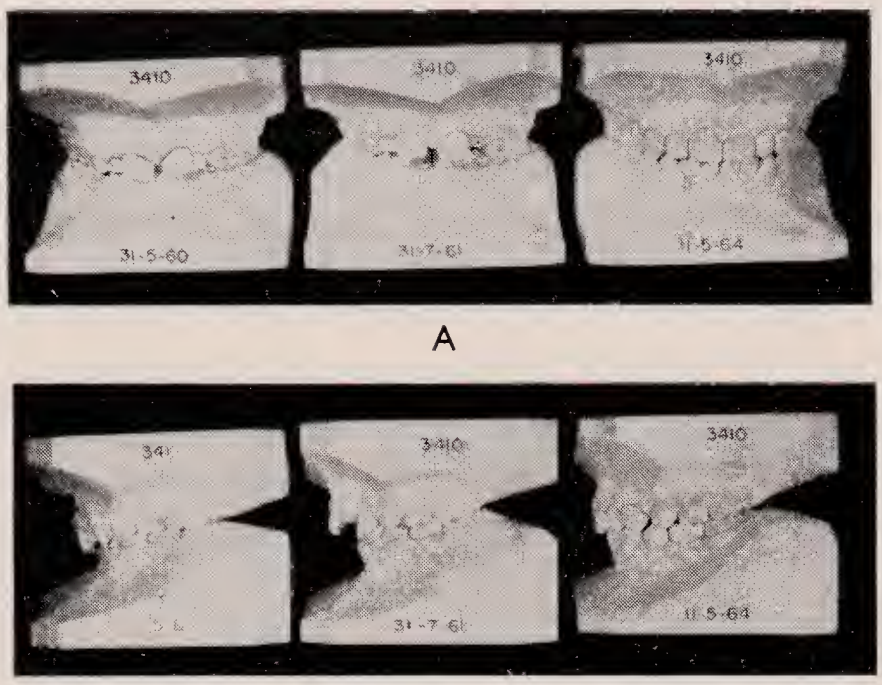


Fig. 4.—*Case* K.M-P. showing A, Anterior view of models; B, Left lateral view; C, Superimposed radiographs.

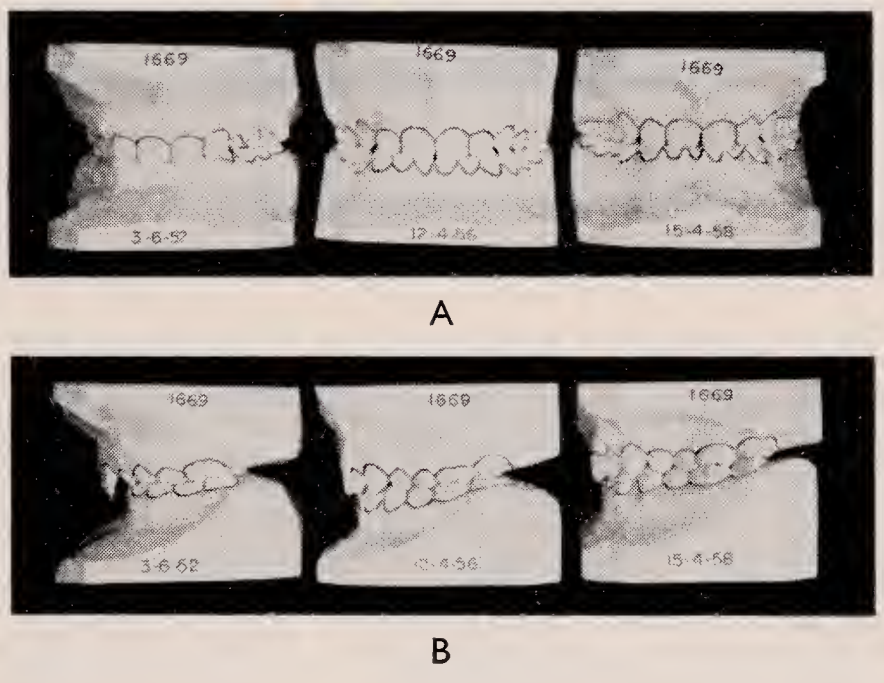


Fig. 5.—*Case* H.J. showing A, Anterior view of models; B, Left lateral view; C, Superimposed radiographs.

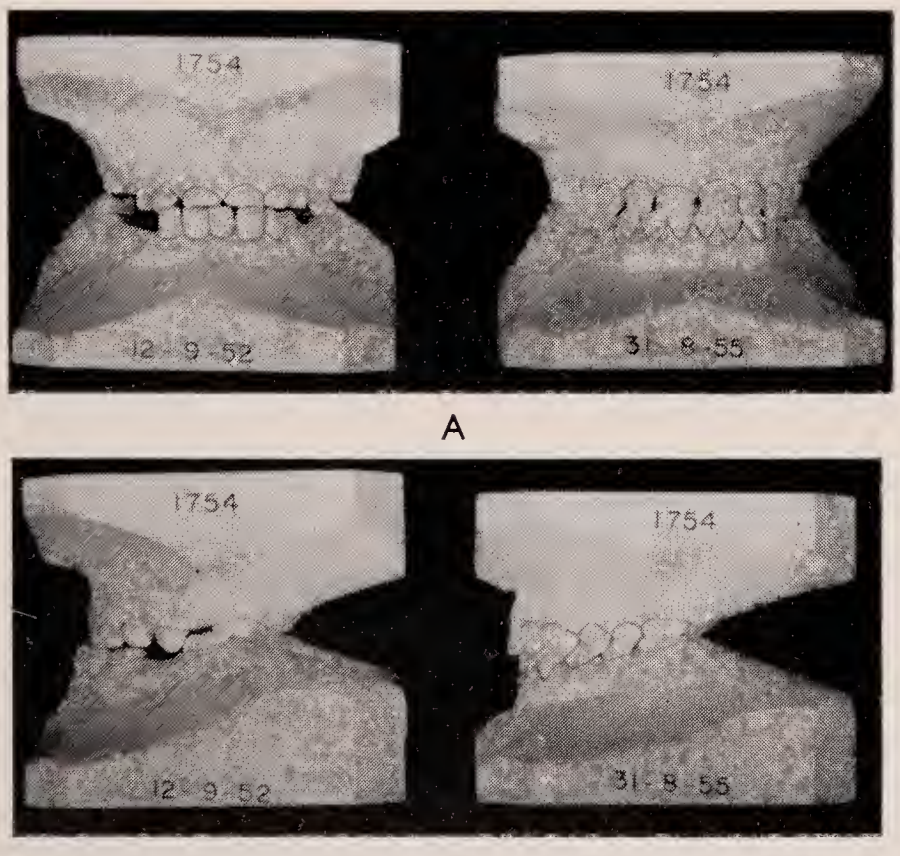


Fig. 6.—*Case* Y.C. showing A, Anterior view of models; B, Left lateral view; C, Superimposed radiographs.

and two years out of retention, and the profile tracings show the case before, after treatment, and three years out of retention. In this case there was a slight worsening of imbrication of the lower incisors, but apart from this there was no change or relapse.

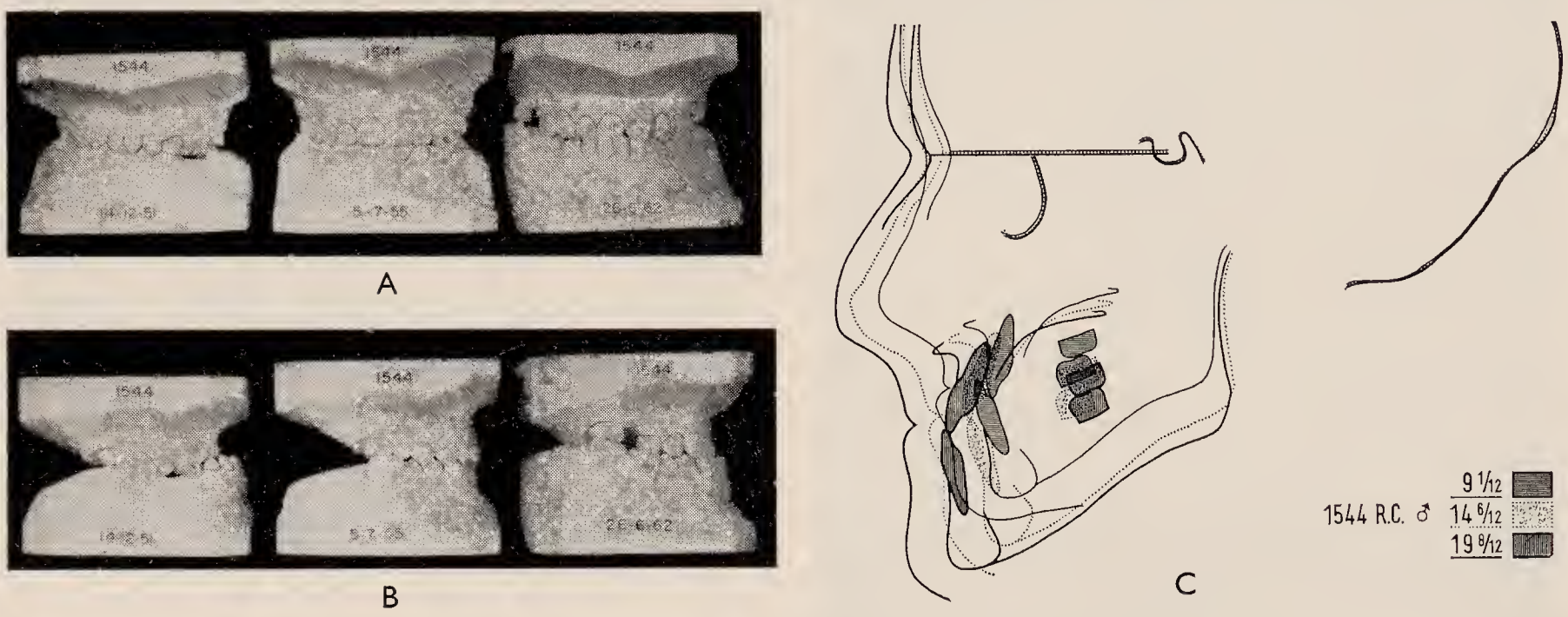


Fig. 7.—*Case* R.C. showing A, Anterior view of models; B, Right lateral view; C, Superimposed radiographs.

CLASS III

The problem of maintaining the distal position in a Class III case treated with an activator is overcome by using a screw between the upper and lower parts of the appliance which is turned by the operator to maintain the jaw in a distal relationship. Cases were shown of the use of this appliance in the deciduous and mixed dentitions.

Case Y.C. (*Fig.* 6) illustrates the use in the mixed dentition, and *Case* R.C. (*Fig.* 7) was shown to emphasize the importance of follow-up in Class III cases. This patient had a sliding activator fitted and an acceptable result was obtained, and he was kept under observation for two years out of retention. The patient then failed to keep his follow-up appointments, and a general practitioner extracted an $\underline{6|}$ during his puberty growth spurt which resulted in relapse of the incisors on the right side.

Other cases showing the use of functional appliances in the rehabilitation following major oral surgery were shown and care was taken to emphasize the fact that the functional appliance is not the panacea for orthodontic ills, but is a most valuable and effective form of treatment for selected cases.

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BITING PLATFORMS IN ORTHODONTIC APPLIANCES

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SINCE biting platforms are frequently incorporated in removable orthodontic appliances, a practical description of how these should be used, constructed, and adjusted would serve a useful purpose, especially when a greater number of general practitioners are undertaking treatment of orthodontic cases. The routinely used and most useful biting platforms are:—

1. Inclined bite plane } Anterior or incisor
2. Flat bite plane } region
3. Posterior bite platform or gag—premolar and molar region.

As a general rule the anterior bite planes are used when the patient has a deep or increased incisal overbite and the posterior biting platform when the overbite is normal or decreased. Because in over 90 per cent of cases only the upper arch needs an appliance, the biting planes are mostly used on an upper plate. Rarely a lower plate with posterior gags may be made, in which case the description of the upper will apply.

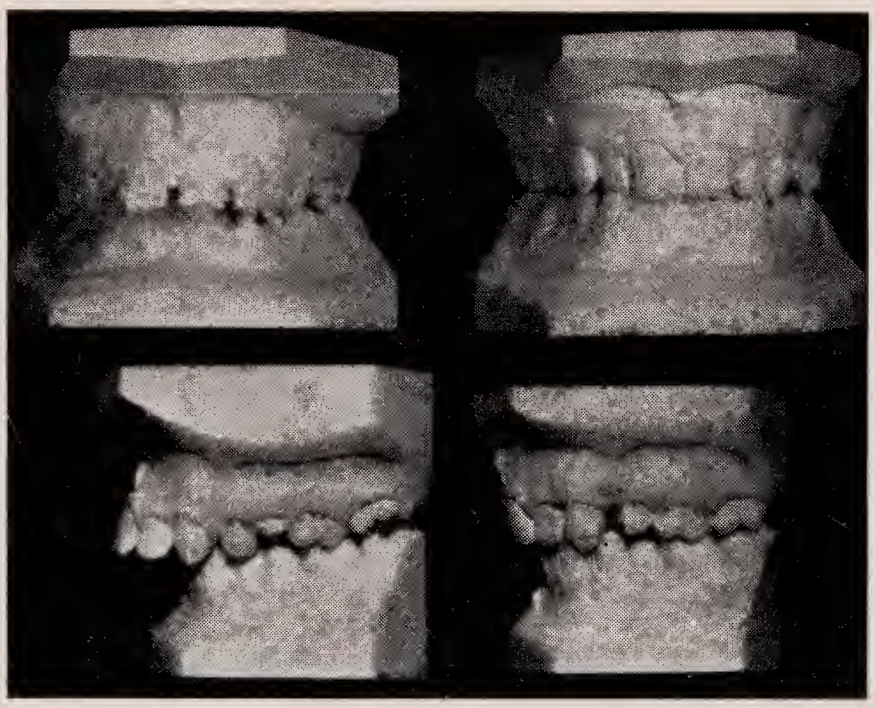


Fig. 1.—Before and after (one year) models of a case show (1) stability of anchorage as seen by maintenance of molar relationship and (2) decrease in overbite (and overjet by retraction of upper incisors).

INCLINED BITE PLANE

This is a sloping portion of acrylic behind the incisors on an upper plate. It functions by virtue of the lower incisors biting on its anterior slope and helps to:—

1. *Increase anchorage* because the plate is pushed upwards and backwards. This is specially useful when retracting two or more anterior or posterior teeth and where reinforcement of anchorage is desired because the patient presents some features of potential danger of anchorage loss, e.g., only a few posterior teeth present as in late mixed dentition, erupting second molars, medially tipped or drifted molars, very proclined upper incisors, shallow and/or sloping palate,

Fig. 2.—Cephalometric tracing of the same case shown in *Fig.* 1 before (———) and after (– – – – –) a year's treatment using an inclined bite plane. (1) The lower molar distance from the lower border of the mandible is increased, but not the upper molar distance from the palate; (2) The lower incisor distance from the lower border of the mandible has not altered, but the angulation has increased; (3) Some growth changes have occurred.

A demonstration presented at the Country Meeting held in Plymouth on 22 May, 1964.

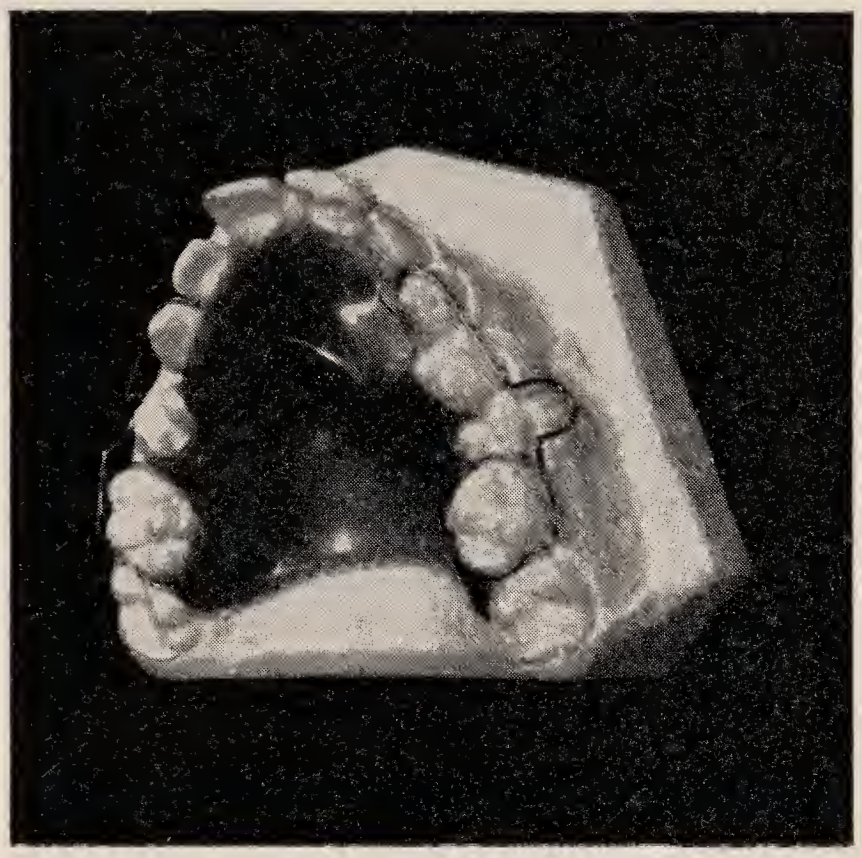


Fig. 3.—Waxed up inclined plane.

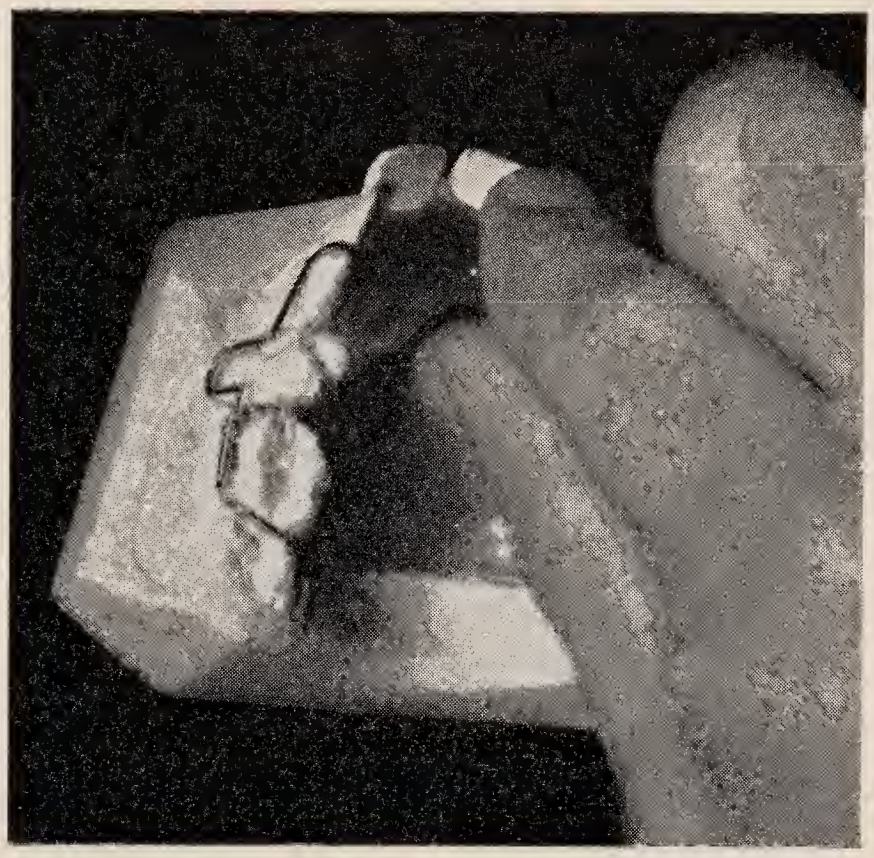


Fig. 4.—Arbitrary ' thumb-forefinger ' angle of the inclined plane.

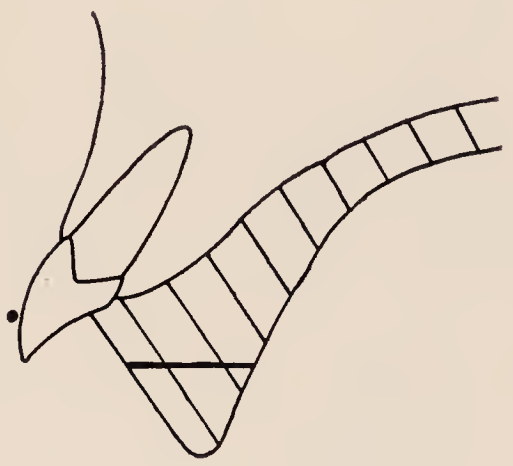
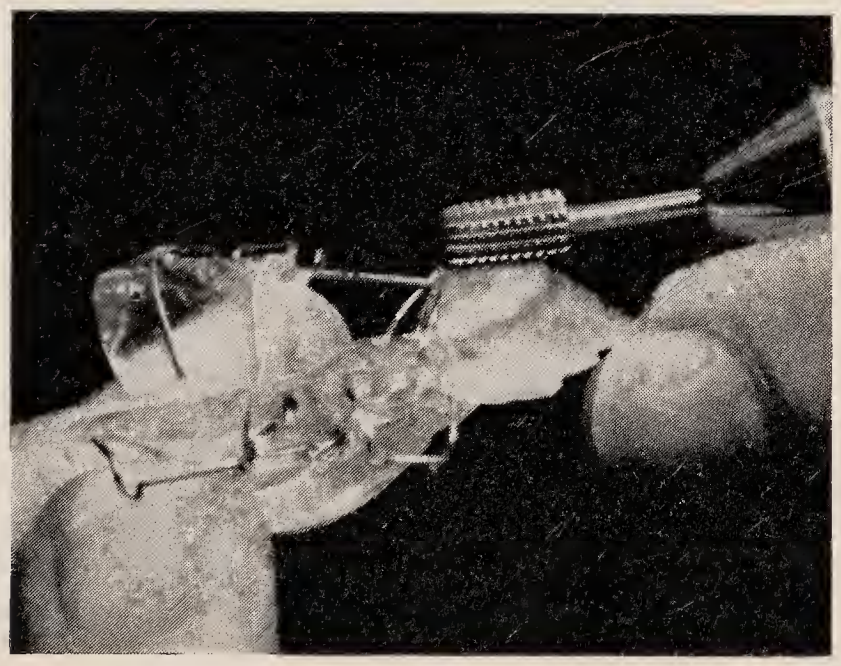


Fig. 5.—Marking of the incisal level on the inclined plane.



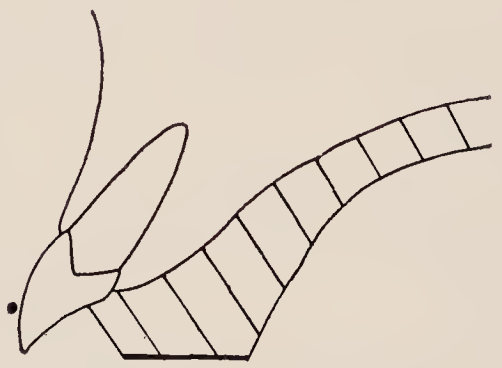


Fig. 6.—Trimming of the inclined plane, flat at the incisal mark.

lower lip trapped behind upper incisors, incompetent upper lip, thumb-sucking, or tongue-thrusting.

2. *Open the bite.*
3. *Slightly procline the lower incisors.*

In the case where two upper premolars were extracted and the canines and, later, incisors were

retracted, the before and after models (*Fig.* 1) at that stage and cephalometric tracings (*Fig.* 2) show that anchorage of the upper posterior teeth has been firmly maintained as seen by their relationship to the lowers, the bite has been opened by occlusal movement of the lower posterior teeth, and the lower incisors have been slightly proclined.

Construction

The inclined plane should be long enough anteroposteriorly to preclude the lower incisors biting behind it; and it should not be higher than the occlusal plane so that it is comfortable and not easily noticeable. Therefore, the inclined plane will vary according to each case and requires individual adjustment. A labial bow with U-loops is usually used in conjunction, as this further aids retention and anchorage.

As it is not practicable to ' try in ' every orthodontic appliance, the inclined plane is first constructed arbitrarily in the laboratory and later adjusted at the chair side. When the plate has been waxed up it is seen that the wax extends about 2 mm. on to the palatal surface of the incisors. A roll of wax is now placed behind the upper incisor and canine area, and shaped to extend backwards and downwards for 10–15 mm., i.e., up to the canine region, at an approximate angle formed by the thumb and forefinger (*Figs.* 3, 4). If in a special case there is a very pronounced overjet of over 15 mm., a longer plane may be waxed up. The plate is then processed in clear acrylic.

Adjustment

Since the inclined plane has been made arbitrarily of a certain length and at the ' thumb-forefinger ' angle, it needs adjustment in the mouth to get the correct height, length, and inclination. The following method of adjustment

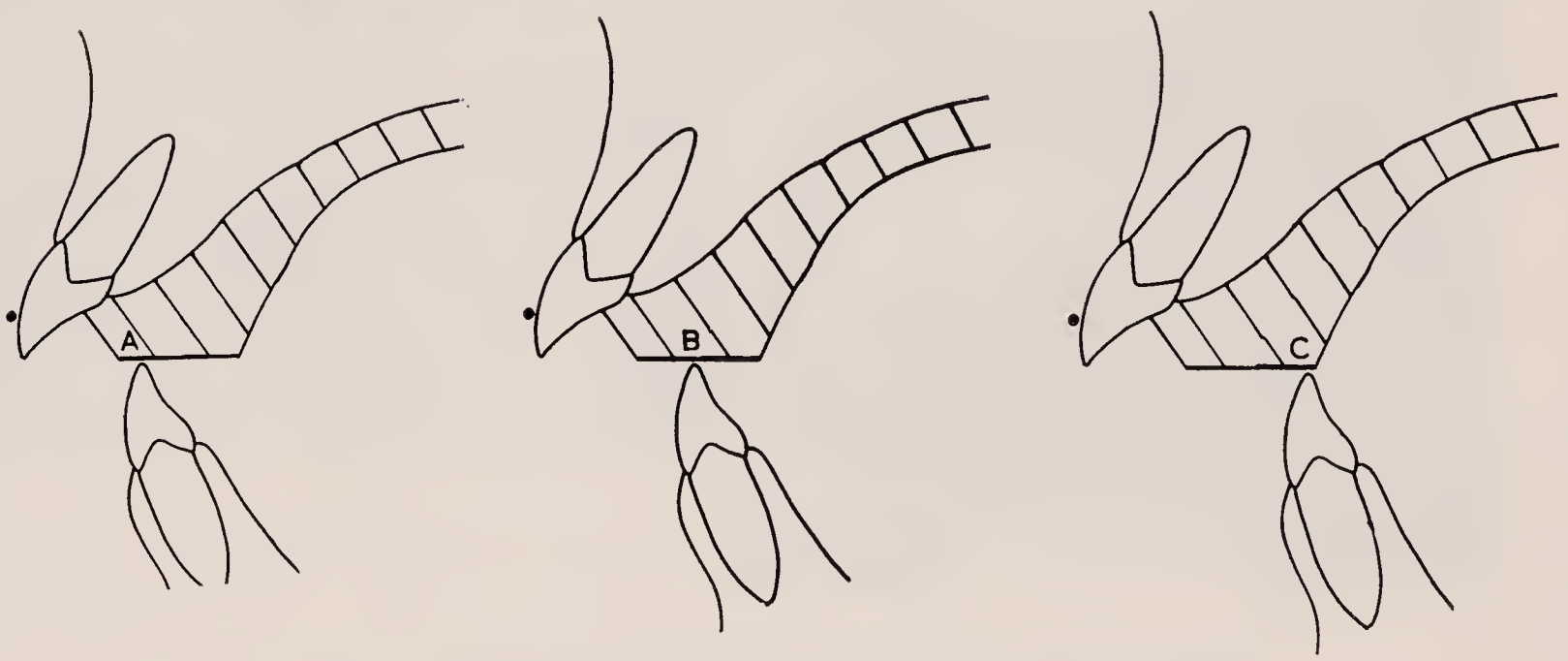


Fig. 7.—Lower incisors biting in the most retruded position, which as illustrated may vary at positions A, B, C, etc.

is quite simple and ensures an accurate and comfortable inclined plane:—

1. Insert the plate and, standing in front of the patient looking level with occlusal plane, mark the inclined plane, with a chinagraph pencil (or if the part is slightly sandpapered, it can be marked with a soft lead pencil) at the level of the upper incisal edges (*Fig.* 5). Remove the appliance and trim the plane flat at this level, thus adjusting the height of the plane (*Fig.* 6).

2. Reinsert the plate and ask the patient to close as far retruded as possible and mark the position of the lower incisors on the trimmed flat part of the inclined plane (*Fig.* 7). Remove the appliance and trim the inclined plane from just behind this marking to the margin of the plate

behind the incisors. This gives the correct incline for that case (*Fig.* 8). Now, any excess behind the plane can be removed and hollowed out to make the plane less bulky (*Figs.* 9, 10).

3. Subsequently, when retracting the incisors with the labial bow retractor, the acrylic behind the incisors should be trimmed from the palatal aspect as indicated (*Fig.* 11), so that an effective inclined plane is still maintained.

FLAT INCISOR BITING PLATFORM

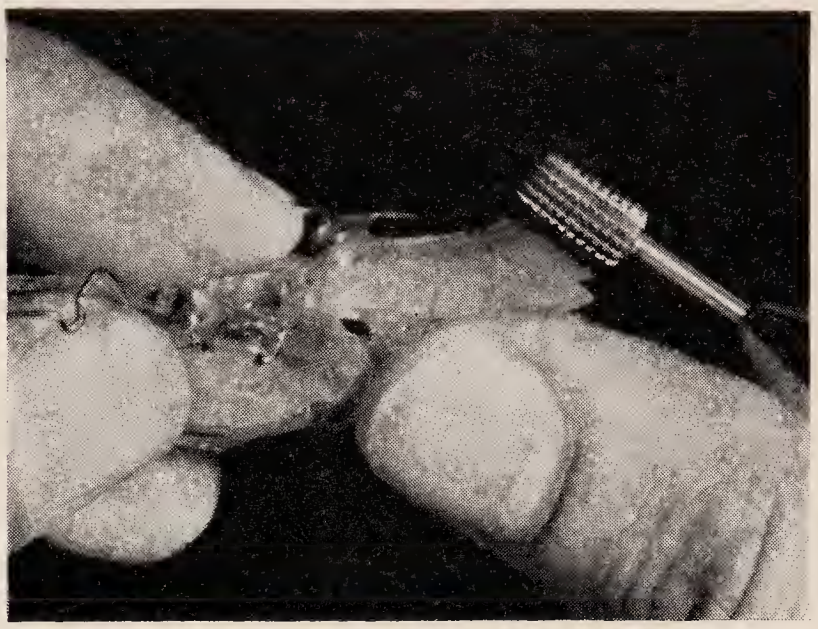
This is a flat, thickened portion of acrylic behind the upper incisors (*Fig.* 12) and is used in cases of deep anterior overbite to:—

1. Open the bite by allowing occlusal movement of the lower posteriors.
2. Reinforce anchorage when a low labial bow is included.
3. Overcome cuspal interference when the upper arch needs lateral expansion or movement of posterior teeth.

Adjustment

The flat biting platform should be adjusted in the mouth so that:—

a. In the vertical direction, when the patient is biting with the plate in the mouth, the upper



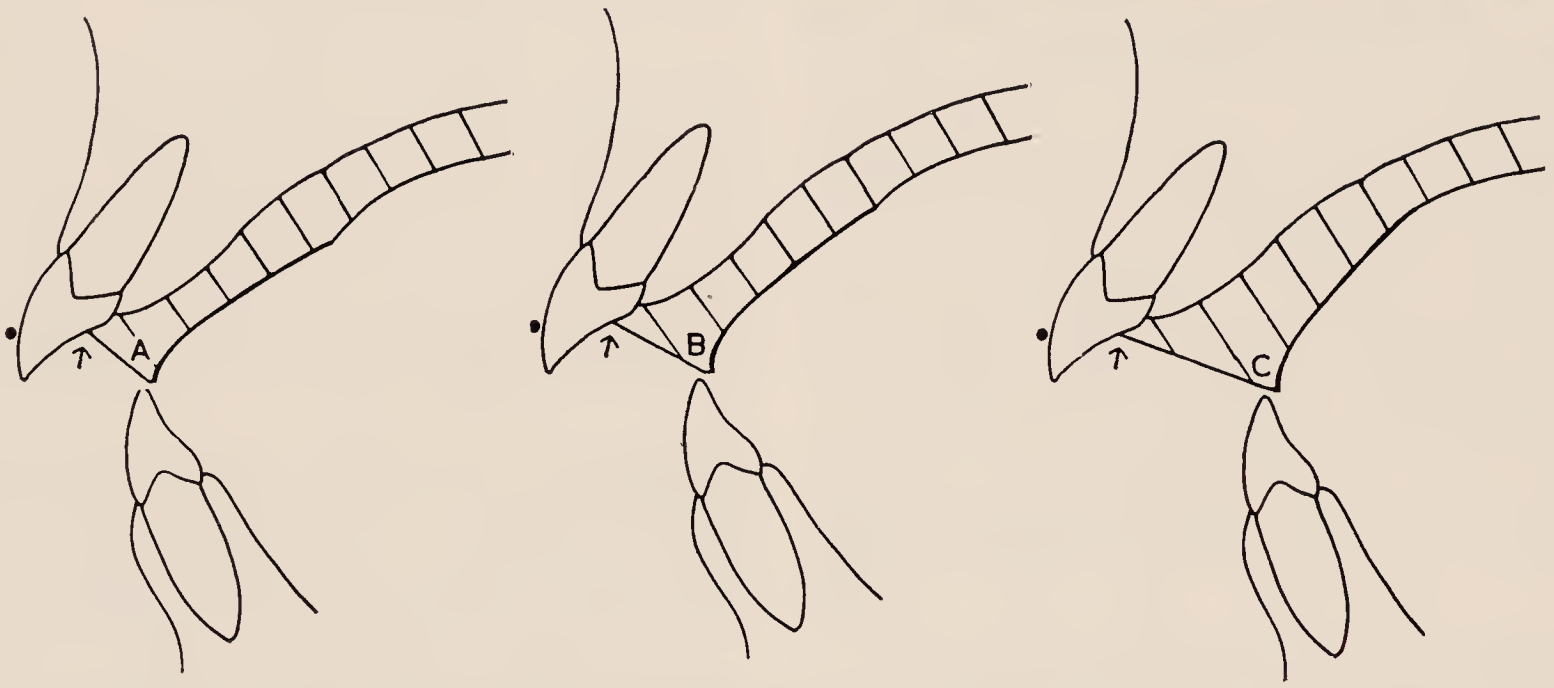


Fig. 8.—Adjustment of the inclined plane to suit the bite at A, B, or C, respectively.

Fig. 9.—Hollowing out of the posterior part of the inclined plane by means of a round acrylic bur.

Fig. 10.—Adjusted inclined plane in the mouth.

incisors cover one-third of the labial surface of the lower incisors when viewed from front along the occlusal plane.

b. Anteroposteriorly the platform extends a fraction more than the most distal biting position of the lower incisors.

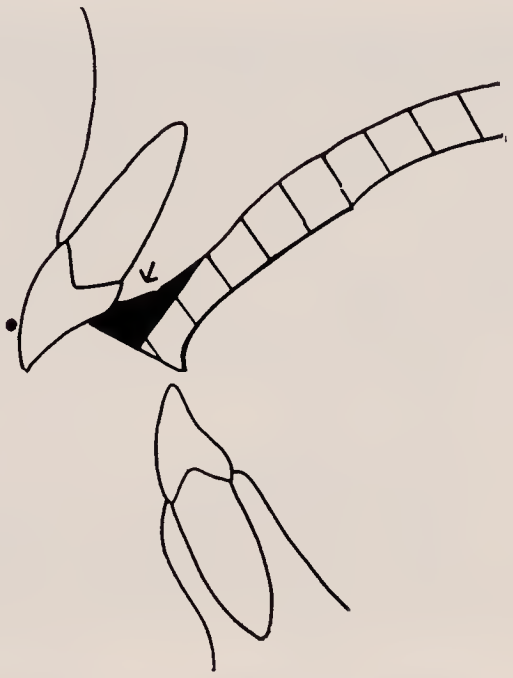


Fig. 11.—Removal of acrylic from the plate when retracting upper incisors.

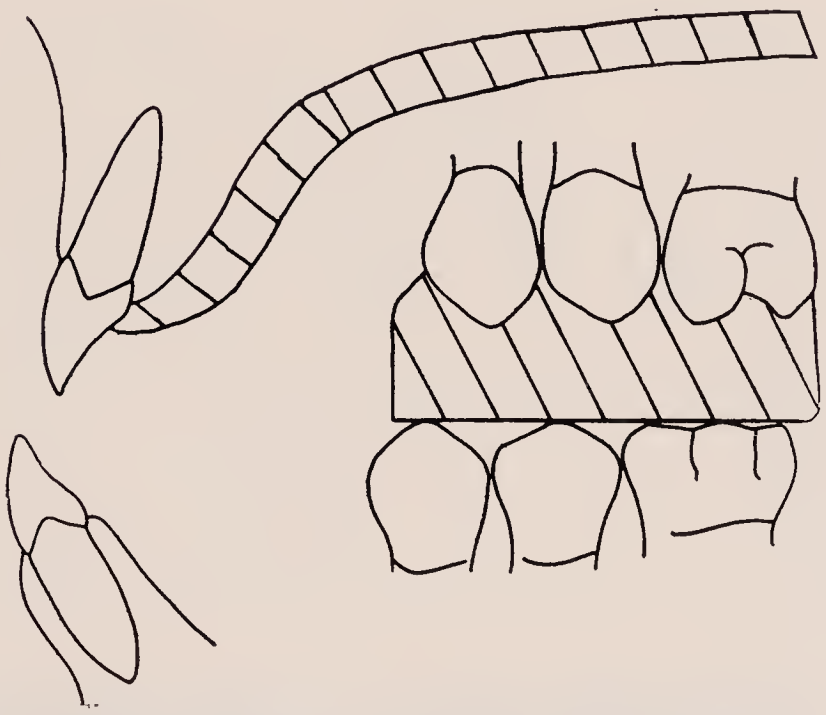


Fig. 13.—Diagram of posterior bite raising or gagging.

POSTERIOR BITE RAISING OR GAGGING

In this case the plate is extended over the occlusal surfaces of the premolar and molar teeth (*Fig*. 13), and this gagging is mainly used in cases where some upper anterior teeth have to be moved over the bite. It is a temporary measure to ' unlock ' the occlusion while the anterior teeth are being moved over the bite, and once this is accomplished the gagging is removed (in one stage if the gag is not more than $1\frac{1}{2}$ mm. thick, and in two stages if it is so).

Adjustment

The gag constructed in the laboratory is usually about three wax thicknesses (3 mm.), and should be adjusted when the appliance is fitted. It is most important that the gag covers every upper tooth from behind the first premolars, and is

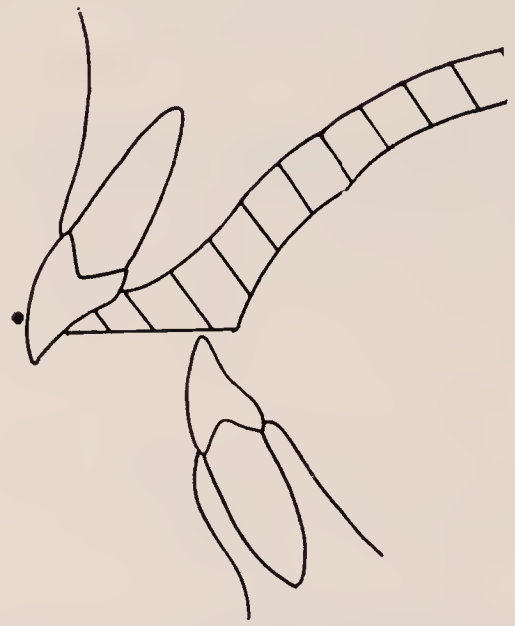


Fig. 12.—Diagram of flat incisor biting platform.

trimmed flat to contact every lower tooth from behind the first premolar. The gag height should be so adjusted as to keep the tooth being corrected about 1 mm. clear of the occlusion.

In cases where the incisor overbite is normal or even tends to be edge-to-edge or open bite, posterior gags may also be used on a plate, for lateral expansion of the upper arch or for distal movement of some upper posterior teeth, in order to overcome cuspal interference. If a premolar is partly erupted the acrylic may be dug out to allow for eruption. However, an erupting second molar must be covered, if not by acrylic at least by a short spur of wire, in order to prevent its over-eruption. If there is any cross-bite of the posteriors, it is better to extend the gag, when waxing up, about 1–2 mm. buccally.

A REPORT ON A SURVEY OF THE ORTHODONTIC REQUIREMENTS OF 310 ARMY APPRENTICES

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MAJOR J. B. WAYMAN
Royal Army Dental Corps

This investigation was started in September, 1962. The actual examinations were carried out by Major Milne, R.A.D.C., of the Oral Pathology Department, Royal Army Medical College, and the models, profile photographs, and completed questionnaires were sent to Professor Ballard for analysis.

The main purpose of this report is not to say that the investigation has produced conclusive facts, but to give the reasons for carrying out such an investigation. As will become evident later, the number investigated was too small. It is known that similar investigations are being undertaken at this time on larger numbers, and the results of such investigations will be of greater importance to future planning of orthodontic services.

In the past, various estimates of orthodontic needs of the population have been made. Gardiner (1956) came to the conclusion that 50·4 per cent of the school population that he examined required orthodontic treatment. Of this group 39·8 per cent required uncomplicated treatment and 10·6 per cent complicated treatment. By comparison the British Dental Association Report on orthodontic services suggested that 15 per cent of the population required orthodontic treatment and of these 5 per cent required orthodontic treatment by specialists. In the case of Gardiner, the estimate was made on the assessment of the degree and types of malocclusion in the population. The British Dental Association Committee had noted the extent of the malocclusions in the populations as assessed by various investigators and no doubt attempted to be more realistic than to assume that all malocclusions required treatment. However, the important thing is that malocclusions are expressions of inherited variation ; they are not the result of pathological processes, nor are they environmentally induced. In other words, in any population group, an assessment of the extent of malocclusion is an assessment of inherited variation in that population as determined by the gene pool. The inherited features are the patterning of the skeletal structures and the soft tissues, the dento-alveolar structures being adaptable to these features (Ballard, 1961). Any analysis of variability must be on the basis of a known mean, calculated from cross-sectional data, but in our view it is wrong to assume, as many orthodontic philosophies do, that any deviation from the mean, incorrectly interpreted as the ' normal ', is an abnormality. Biologically it should no more be regarded as an abnormality than should an individual who deviates from the mean height of the population by more than the standard deviation. Furthermore, longitudinal studies indicate beyond dispute that some combinations of inherited factors do not permit a reduction by orthodontic therapy of the dento-alveolar deviation to anything approaching the mean.

If, then, the orthodontist is dealing in the main with inherited variation, how should the treatment requirements of any population group be assessed? Before answering this question it is necessary to discuss briefly why orthodontic treatment should be carried out.

The most frequent and valid reason for wishing to have orthodontic treatment is undoubtedly poor appearance. The aesthetic standards of body form in an ethnic group are, most probably, subconsciously based on the average for that group. It can be said, therefore, that an individual who requires orthodontic treatment for the sake of appearance is one who deviates from the mean for the population to an unacceptable degree. For the sake of that individual's mental well-being, the dento-alveolar deviation must be reduced towards the mean, but not necessarily to it. Orthodontists who always attempt to produce a type of occlusion based on a mean will fail in their objectives in certain cases and will only

Presented at the Country Meeting held in Plymouth on 23 May, 1964.

hold the results of active treatment by prolonged retention in other cases. Such an approach to therapy is biologically unsound, but is often inspired by commercial considerations.

A second reason for orthodontic treatment is undoubtedly that the malrelationship of the teeth predisposes to disease. Investigations are being carried out at the moment on this aspect. So far one would be more inclined to suggest that the majority of malocclusions develop naturally into a position of physiological balance and that they are only more susceptible to disease as the result of the failure of the dental service to avoid loss of teeth. A malocclusion is possibly in a more delicate physiological balance than an occlusion near to the ideal, and therefore more easily put out of balance by the loss of one tooth or even the loss of a contact point. Another important reason for orthodontic therapy is that tooth relationships do not permit an acceptable articulation of the sounds of the individual's language (Ballard and Bond, 1960).

Perhaps the most frequent reason for referring patients for orthodontic treatment is that a dental practitioner has spotted a malocclusion and quite possibly explained to the individual and parents that failure to have it treated may be disastrous. The consequence of this approach to malocclusion may easily lead to treatment being instituted on an uncooperative patient, or that the consultant or specialist finds that treatment is unnecessary.

If the foregoing is a correct assessment of the aetiology of orthodontics, then it follows that orthodontic treatment should be (1) provided for those who are genuinely concerned about their appearance and whose mental well-being is likely to be disturbed, and (2) offered to those whose occlusion is such that it is likely to predispose to disease.

The selection of patients for orthodontic treatment, therefore, should not be on the basis of the presence or absence of a malocclusion. In selection and treatment two important considerations have to be borne in mind. The first is that, in treatment for aesthetic reasons, the aim is to reduce the variations towards the mean of the population and not to attempt the impossible. The second is that orthodontic treatment is a disturbance of the phylogenetically and ontogenetically determined relationship. Such disturbance may reduce the resistance to disease, even if planned with this fact in mind.

It follows from this that, at least for a certain proportion of the population requiring orthodontic treatment, an orthodontist of considerable clinical experience should carry out the treatment planning.

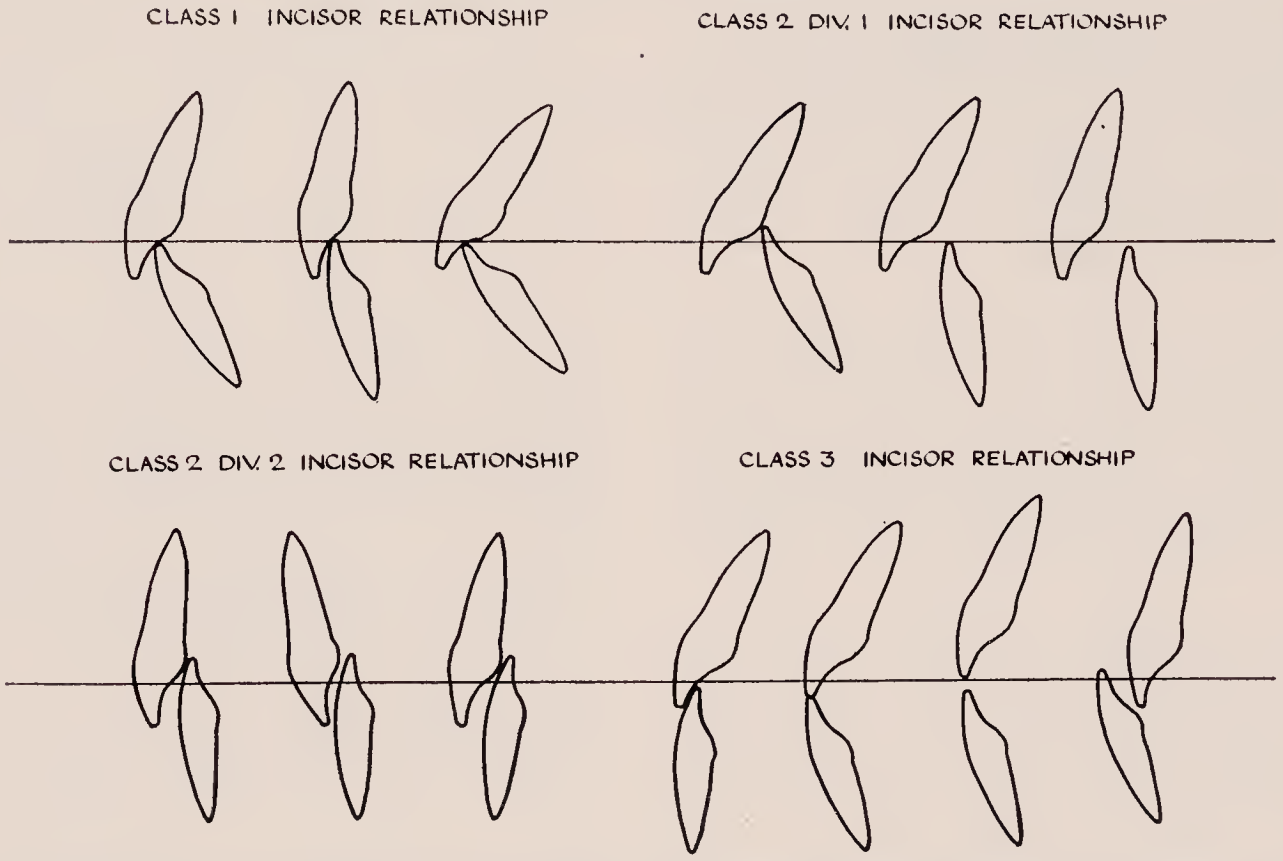
CLASS 1 INCISOR RELATIONSHIP
CLASS 2 DIV. 1 INCISOR RELATIONSHIP
CLASS 2 DIV. 2 INCISOR RELATIONSHIP
CLASS 3 INCISOR RELATIONSHIP

Fig. 1.—The application of Angle's classification of occlusal abnormalities to variations of incisor relationship. (Using Backlund's (1958) criteria for Class I.)

THE INVESTIGATION

Three hundred and ten Army Apprentice Recruits, aged $15\frac{1}{2}-16$ years, were to have their initial army dental inspection at the Army Dental Centre, Chepstow. Permission was given by the Director of the Army Dental Services for a concurrent orthodontic assessment to be made, and this was done, as already mentioned, by Major Milne. The fact that the apprentices were not seen by a specialist orthodontist might be criticized, but this will be dealt with later.

A questionnaire was filled in for each individual, an assessment made of their appearance, and each recruit was asked for his own opinion of his

teeth. It is not proposed to go into the details of the questionnaire because, as has already been stated, further investigations on larger numbers will produce, it is hoped, more conclusive figures.

Table I.—Distribution of Classes

Total examined		310
Full upper dentures		4
Total for analysis		306
Class I	204	66·7 per cent
Class II, division 1	34	11·1 per cent
Class II, division 2	33	10·8 per cent
Class III	35	11·4 per cent

The inspection of the models was carried out with the following objects in mind:—

1. A classification of the tooth relationship.
2. The state of the mouth in terms of the dental treatment the individual had received in the past.
3. Whether or not the individual could benefit from orthodontic treatment from the point of view of (*a*) aesthetics and (*b*) function.

The two criteria as to whether orthodontic treatment should have been offered to the individual were: (i) on the basis of his answer as to whether or not he was satisfied with his teeth; and (ii) the state of his mouth as judged by the number of carious and extracted teeth.

With regard to the classification of the cases, this was done on the basis of the application of Angle's occlusion as applied to the incisor teeth (*Fig.* 1). In detail it was in the terms of Backlund's (1958) analysis of the normal overbite occlusion, that is:—

1. An occlusion on the second part of the lingual surface of the upper incisors was a Class I occlusion.
2. Increase of overjet from this position was a Class II, division 1.
3. A lingual inclination of the teeth which did not permit an occlusion of lower incisors on the second part of the upper incisors and which was invariably associated with an increased overbite, was a Class II, division 2.
4. A Class III type was a reduction of overbite and overjet—in other words, labial surface of lower incisors occluding against the lingual surface of the first part of the upper incisors, or an edge-to-edge, or open bite, of Class III overjet.

The criticism that one cannot judge what is required to improve the appearance of the individual from models alone is no longer valid for an orthodontist of many years of experience in relating variations of occlusion to skeletal pattern and soft-tissue behaviour. It is only necessary for him to look at a set of models to know what the individual looks like. For this reason alone an investigation in this form was thought to be worth while.

The group consisted of 310 boys, all between the ages of $15\frac{1}{2}$ and 16 years (*Table I*). Four had full upper dentures and therefore only 306 come into the total analysis.

The Class I cases totalled 204 (66·7 per cent). Class II, division 1 cases totalled 34 (11·1 per cent). Class II, division 2 cases totalled 33 (10·8 per cent), and Class III cases totalled 35 (11·4 per cent).

Table II.—Class I, Incisor Relationship
(Total in Group = 204)

Not satisfied with appearance (all could have been treated)		4	2 per cent
Satisfied with appearance, but would benefit from treatment		22	10·7 per cent
Reasons for treatment of 22:			
Crowding of incisors	11		
Spacing of incisors	6		
Buccal segment crowding	5		
Past successful treatment		4	2 per cent
Total treatment in the group		30	14·7 per cent

The analysis of Class I cases was as follows (*Table II*):—

Two had not been satisfied with their appearance in the past, but were now content. In other words, they would have liked treatment had it been available to them in the past. Both cases could still be improved aesthetically.

Four were not satisfied with their appearance and would now like treatment. The first of these should be treated for aesthetics and function, the left upper lateral being in cross bite; the second for aesthetics (there was poor appearance due to incisor crowding); the third for aesthetics and function (incisor spacing and canines in the palate); and the fourth for aesthetics (incisor crowding).

Including these 4, there were 26 out of the 204 who would have benefited from orthodontic treatment—11 for crowding of incisors, 6 for spacing of incisors, and 5 for buccal segment crowding. The reason for carrying out orthodontic treatment for these conditions was that 12 would have benefited from improvement of appearance, 10 for improvement of function, and 4 for both reasons.

To the total of 26 has to be added 4 who have had successful orthodontic treatment in the past.

Of the 34 (11·1 per cent) Class II, division 1 cases (*Table III*), there were three who were not satisfied with their appearance. The first could have been treated without extractions; the second and third should not have been treated, one because his incisor malrelationship was of a minor degree and did not justify mutilation of the mouth, and the other because his mouth had already been so badly mutilated that appliance therapy would not have been justified. Of the remaining 31: (*a*) 21 had an occlusion which should not have been treated because the appearance would not have deviated from the mean sufficiently to justify mutilation of the occlusion; (*b*) 1 had an occlusion which could have been treated to improve function; (*c*) 9 had an occlusion which could have been treated had the patient desired it for aesthetic reasons: but (*d*) 3 would have been refused because of the state of their mouths.

The analysis of treatment was that: 6 could have been treated with removable appliances after extraction of $\frac{4|4}{}$; 2 could have been treated by extraction of $\frac{7|7}{}$ and extra-oral anchorage; 2 could have been treated without extraction, 1 of these by removable appliance. Including those who had been successfully treated in the past—a total of 12.

Table III.—Class II, Division 1 Incisor Relationship
(Total in Group = 34)

Not satisfied with appearance	3		8·8 per cent
Number for treatment		1	2·9 per cent
Satisfied with appearance, but would benefit from treatment		10	29·4 per cent
Reasons for treatment of 10:			
To improve function	1		
for aesthetics	9		
(3 would have been refused treatment because state of dentition would not justify)			
Past successful treatment		1	2·9 per cent
Total treatment in the Group		12	35·3 per cent

In the Class II, division 2 group of 33 (*Table IV*) 3 could be excluded because they had had successful treatment in the past; 2 were not satisfied with their appearance and could have had treatment—one by extraction of $\frac{4|4}{}$ and the other to continue unsuccessful treatment given in the past; 23 of the remaining 28 had such an occlusion (although Class II, division 2) that treatment would have mutilated the mouth to an extent not justified by the degree of deviation; 3 would have benefited from treatment to improve function or relieve potential trauma; and 2 would benefit from treatment for aesthetics.

Therefore only 5 of the 28 cases would now benefit from treatment. This produces a total of 10.

Table IV.—Class II, Division 2 Incisor Relationship
(Total in Group = 33)

Not satisfied with appearance (Both could have been treated)		2	6 per cent
Satisfied with appearance, but would benefit from treatment		5	15·1 per cent
Reasons for treatment of 5:			
To improve function	3		
For aesthetics	2		
Past successful treatment		3	9·9 per cent
Total treatment in the group		10	31·0 per cent

Of the Class III cases (35 out of 306) (*Table V*), it is interesting in the first instance to analyse them in terms of the detail of their incisor relationship: 24 had edge-to-edge bite; 1 had a cross bite; 4 had a Class III overjet after displacement; none had a Class III overjet without displacement; 5 had edge-to-edge and cross bite; and 1 had a cross bite with displacement.

It should be noted that these are all minor degrees of Class III incisor relationship.

Four of these cases were not satisfied with their appearance: 1 had an edge-to-edge bite with what could be regarded as successful treatment in the past, and no further treatment was advised; 1 had a displacement and cross bite, and this could be treated; 1 had had unsuccessful treatment in the past, and displacement which should have been treated; 1 had edge-to-edge and cross bite which should have been treated for both aesthetic and functional reasons; making a total of 3 who could reasonably have been offered treatment.

Thirty one out of the 35 were satisfied with their appearance. Of these: 4 could have been treated for aesthetics; 2 could have been treated for function; and 6 for aesthetics and function. This makes a total of 16.

There are two other details of the investigation which we thought to be worth mentioning. The first is that none of the primary malocclusions seen could be classified as severe by comparison with a cross-section of cases referred to the Orthodontic Department of the Eastman Dental Hospital. All but one of these cases could have been treated by general dental practitioners who are reasonably competent with removable appliances. In only one case a rotation would have been difficult with a removable appliance. For this type of investigation, therefore, much larger numbers are required.

The second detail of the investigation relevant to the provision of orthodontic treatment was the state of the dentition as indicated by absence of teeth. An analysis of this was made very briefly. Four of the individuals had full upper dentures by the age of 16 years, 221 of the 306 remaining had their mouths mutilated to a greater or lesser extent by failure of dental care.

In many of these mouths, if orthodontic treatment had been contemplated, multiband therapy would have been necessary to repair the damage caused by the lack of conservation in the past. However, the Army Dental Services are continuing the investigation on the group, having made them dentally fit at the time of intake, by continuing to keep accurate records of work done on these mouths.

Table V.—Class III Incisor Relationship
(Total in Group = 35)

Analysis			
Edge-to-edge	24		
Cross bite	1		
Edge-to-edge and cross bite	5		
Class III overjet with displacement	4		
Class III overjet without displacement	—		
Cross bite with displacement	1		
Not satisfied with appearance	4		11·8 per cent
Number for treatment for aesthetics and function		3	8·6 per cent
Satisfied with appearance, but would benefit from treatment		12	34·2 per cent
Reasons for treatment of 12:			
For aesthetics	4		
For function	2		
For aesthetics and function	6		
Past successful treatment		1	2·8 per cent
Total treatment in group		16	45·6 per cent

SUMMARY OF THE FIGURES

Of the total of 306: 4·2 per cent were not satisfied with their appearance; 3·3 per cent should have treatment; 16 per cent, although satisfied with their appearance, could, under ideal circumstances, have had treatment.

Reasons for treatment were divided as follows: 9·8 per cent for aesthetics; 5·2 per cent for function; 4·2 per cent for aesthetics and function.

Add to these groups the number who had had successful treatment in the past, and the total is 68 or 22·2 per cent.

DISCUSSION

This investigation suggests that less than 25 per cent of the population might require

orthodontic treatment and that if the treatment required is supervised by an orthodontic consultant, then much of it can be carried out by general dental practitioners with special interest, or by people less experienced than consultants.

It is interesting to note that classifying by type of incisor tooth relationship rather than by molar occlusion, the percentage of Class II, division 1, Class II, division 2, and Class III are similar. This is to be expected in an inherited condition multifactually determined. It was also interesting to find no severe malocclusion in this group; this suggests that waiting lists in hospital orthodontic departments have made general practitioners treat the simpler cases and only refer the difficult cases to hospital.

CONCLUSIONS

If these figures are anything like those which would result from a similar investigation on a much larger group, then they can be applied to the population as a whole on the following basis.

If there are 700,000 schoolchildren in each age year, then the maximum number who could possibly require orthodontic treatment in any one year is 22·2 per cent (155,400). Of this group, a percentage varying from area to area will be satisfied with their appearance and not request treatment.

Finally, the investigation suggests that much of the orthodontic therapy that might be required can be carried out by general dental practitioners or specialists with less experience than consultants, as long as a consultant is available to plan the treatment.

Acknowledgements

The Authors are indebted to Major A. M. Milne, R.A.D.C., for his invaluable assistance, and wish to express their thanks to Col. E. G. Elliott, R.A.D.C., of the Army Dental Centre, Chepstow, and to the Commandant of the Army Apprentices School, Chepstow, for making this investigation possible.

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DISCUSSION

Mr. J. C. Stephenson asked if the figures could be applied to the population at large. Was a group of Army apprentices a true sample of the population? Could the small number of Class II, division 1 cases be due to the fact that a ' goofy ' appearance was not felt to be compatible with a military career? Did recruiting officers tend to dissuade boys of that type and show a preference for a skeletal III appearance?

Major J. B. Wayman (in reply) said that this was not so. He did not think that boys who passed through Army trade schools would be different in any marked way from boys of similar academic standard passing through other schools. They all had to pass an entrance examination and many had a number of G.C.E. ' O ' level passes.

Mr. S. Haynes said that the figures related to boys only. There had been no normal occlusions in the figures. In such a high number as 306 it was hard to believe that everyone had a malocclusion. Further, there was a high proportion of Class II and Class III.

Dr. J. R. E. Mills said that this was not Angle's classification of *malocclusion* but Ballard's classification of *occlusion*, based on the incisors. Therefore, ' normal ' occlusion came in Class I. There would be a large number of cases in Class II, division 2, and also in Class III which would be acceptable occlusions, except that they would have either an increased or a decreased overbite.

The President (Dr. W. J. Tulley) said that it was shown finally that 22 per cent require treatment in the total group, which was approximately the same as he had found in a sample of 1500 11-year-olds. Professor Ballard and he had very similar ideas about which cases needed treatment and which did not. Much re-thinking was needed on what constituted a malocclusion.

Mr. S. Haynes said that the weakness of the investigation was that they were Army recruits. There was a likelihood that the demand would be much lower in a group of grammar school children.

Mr. G. H. Steel said that numbers were not quite so important as selection of sample. A sample of 310 boys chosen from different social groups throughout the country would have been acceptable, but not 310 from one limited section of the population.

The President repeated that the figures revealed by this survey coincided closely with a large cross-section of children at different levels of education.

Professor D. P. Walther said that his analysis in East Anglia had shown that 40—45 per cent required treatment.

The Chairman said that a certain amount of subjective opinion was required and one could not be entirely objective, although Professor Ballard and Captain Wayman had done their best to be objective.

Professor D. P. Walther said that probably their standard was not quite the same. In his analysis three different investigators had given an opinion. All three were within very close limits.

THE INFLUENCE OF THE FACE HEIGHT UPON THE INCISOR OCCLUSION AND LIP POSTURE

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THE relationship of the mandible to the maxilla has long been noted as having a bearing upon the incisor occlusion. In this paper the influence of the face height upon the incisor occlusion will be examined. It is suggested that the vertical relationship of the lower jaw to the upper influences the appearance of the patient's face and the position of the teeth.

Children with deep overbites, normal overbites, and anterior open bites were radiographed. The cephalometric films were examined so that the face heights and the development of the incisor regions in the three groups could be compared. The heights of the upper and lower lips in the three groups were also compared.

REVIEW OF THE LITERATURE

A number of authors agree that there is an association between the height of the face and the degree of overbite.

Björk (1939) finds an inverse relationship between the face height and the overbite. Wylie (1946) finds that the total face height, the lower face height, and the intermaxillary space are significantly less in deep overbite cases. Smeets (1962) has similar findings. Wendorff (1956) finds a substantial increase in the lower face height of patients with anterior open bite.

The vertical development of the incisor and molar regions has been compared with overbite. Smeets (1962) finds no difference in the upper and lower incisal development in cases of deep overbite and cases of normal overbite. Wendorff (1956) finds no increase in the lower incisor height in patients with anterior open bite. The findings of Prakash and Margolis (1952) are similar in general to the above.

The association between the circumoral soft-tissue pattern and the face height has been examined by a number of authors. Atherton and Goose (1965) found that the degree of incompetence appeared to be related to the magnitude of the lower face height, but not to that of the upper lip length. Backlund (1963) finds that the degree of incompetence varies directly with the lower face height, but lip length did not vary with face height.

METHOD

The relationship between the lower face height and the incisor occlusion was investigated by a comparison of these measurements in three groups of children. The first group had a deep overbite, the second a normal overbite, and the third an anterior open bite. There were thirty children aged between 12 and 14 years in each group. Lateral skull radiographs were taken with the child's head held in a cephalostat. The following dimensions were taken directly from the radiographs with fine-pointed callipers:—

1. *The Lower Face Height.*—The anterior nasal spine to the lowest point on the mandibular symphysis, measured with the teeth in centric occlusion.
2. *The Upper Face Height.*—The anterior nasal spine to the nasion.
3. *The Lower Incisor Height.*—The incisal edge of the lower incisor to the lowest point of the mandibular symphysis.
4. *The Upper Incisor Height.*—The incisal edge of the upper incisor to the anterior nasal spine.

RESULTS

An analysis of variance shows that at the 1 per cent level there is a significant difference between the lower face height of the three groups. There is no significant difference between the upper and lower incisal heights in the three groups. The upper face heights showed a significant difference at the 5 per cent level between the deep overbite group and the anterior open bite group. The normal overbite group did not differ significantly from the other two. The mean upper face height increases as the mean lower face height decreases. An analysis of covariance was carried out to see if there was any linear connexion between the individual upper face heights and the lower face heights. This analysis gave an insignificant result (*Table I*).

Presented at the Country Meeting held in Plymouth on 23 May, 1964.

DISCUSSION

The results show that although there is a significant difference between the lower face heights in the three groups, there is no significant difference in the development of the upper and lower incisor regions. There is no overdevelopment of the lower incisor region in either patients with a deep overbite or an anterior open bite. It would appear that whilst the depth of overbite is inversely associated with the lower face height, the latter has no influence upon the vertical development of the upper and lower incisors. The author would like to put forward the following hypothesis and examine it more closely: that the lower face height to a large extent determines the depth of overbite.

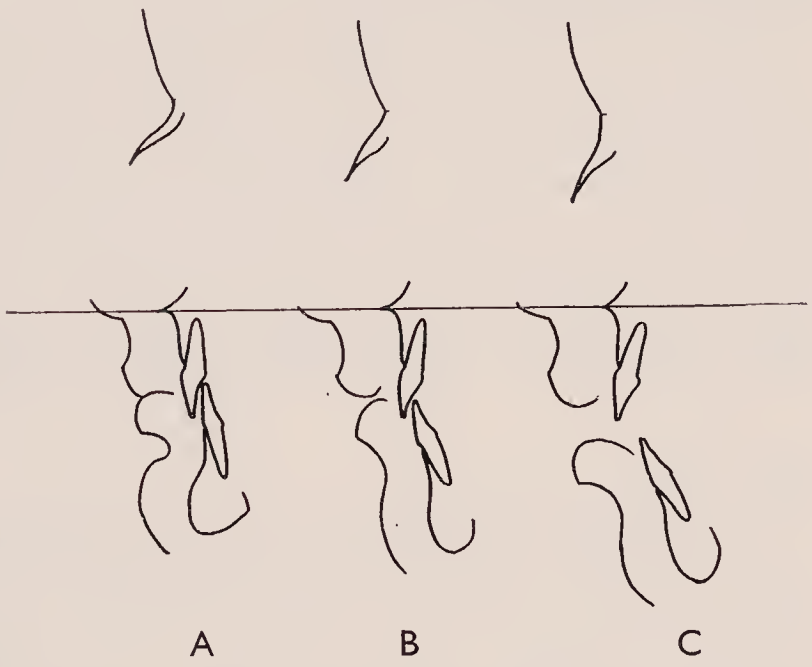

Fig. 1.—A diagrammatic representation of the facial pattern in children with A, a Class II, division 2, B, a Class I, and C, anterior open bite, incisor relationship.

In patients with a long lower face height the incisal region fails to develop in excess of the average to overcome the increased distance so that there is a reduced overbite or an anterior open bite (*Fig.* 1). In patients with a normal lower face height the incisal development is in balance and a normal overbite is achieved. In patients with a short lower face height, the chisel shape of the incisors enables the lower and upper incisors to erupt past each other and to achieve a normal degree of vertical development leading to a deep overbite. The short lower face height may also contribute to the typical upright position of the incisor teeth, for as the incisors erupt into an area enclosed and controlled by the lower lip with a strong tendency to achieve normal development they will tend to upright in order to erupt past each other. The vertical development of the premolar and molar region differs from that of the incisor region because the articulating occlusal surfaces of this area prevent these teeth developing past each other. Therefore, the molar and premolar development is controlled by the mandibular maxillary relationship. The apparent ' kick-up ' of the lower incisor region in patients with a deep overbite is due to the control of the development of the buccal segments rather than an overdevelopment of the incisor segments.

A low lower face height is commonly associated with two further types of incisal relationship—patients with bimaxillary protrusion of the incisors and patients with a large increase in the overjet and the lower incisors biting deeply on to the palate. These patients tend to have a low lower face height but full development of the incisal segments is still achieved.

It is now proposed to examine the implications of this hypothesis upon various incisal relationships.

Table I.—Mean Measurements of Face and Incisor Height in Three Depths of Overbite

	Deep Overbite	Normal Overbite	Anterior Open Bite	
Lower face height	6·3 cm.	6·9 cm.	7·6 cm.	$F = 43{\cdot}3$ significant difference at 1 per cent.
Upper face height	5·6 cm.	5·4 cm.	5·3 cm.	$F = 4{\cdot}8$ significant difference at 5 per cent between deep over and anterior open bite.
Lower incisor height	4·2 cm.	4·2 cm.	4·3 cm.	$F = 2{\cdot}51$. No significant difference.
Upper incisor height	3·1 cm.	3·2 cm.	3·15 cm.	$F = <1$. No significant difference.

a. A Comparison of Patients with an Increased Overjet and Lower Incisor Biting on the Palate with a Similar Group of Patients where the Lower Incisors fail to contact the Palate

Similar measurements were recorded from cephalostat radiographs taken of patients with an increased overjet. In 20 of these patients the lower incisors were biting on the palate (complete overbite) and in 20 patients the lower incisors failed to contact the palate (incomplete overbite).

The findings are recorded in *Table II.*

Using Students '*t*' test, a significant difference is shown to exist between the lower face heights in these two groups of patients. The group with a complete overbite had a shorter lower face height than the group with an incomplete overbite. The lower incisor height is not significantly different. These findings do not exclude the role of habits, such as thumb-sucking, or of an adverse swallowing pattern producing a tongue-thrust as factors in producing an anterior open bite or an incomplete overbite. However, it would appear that the longer lower face height associated with normal development of the incisor region is an important feature in the production of an incomplete overbite. The incomplete overbite group tends to resemble the group with an anterior open bite, in the vertical dimension.

b. The Upper Incisal Segment

It is difficult to measure the vertical development of the upper incisor region because of the shortening effect of proclination upon this measurement. However, it would appear that the vertical development of the upper incisor region is similar in different circumstances. For example, in identical twins where the incisors of one twin are proclined and the other retroclined the general incisal alveolar development is similar. The inclination of the incisor appears readily susceptible to pressure from the soft tissues or orthodontic forces, but not the vertical development. The upper incisal segment appears to behave as a flap hinged about the midpoint of the root. The behaviour of the incisor region during orthodontic retroclination is difficult to determine because of the effect of bite opening, but it would appear that those patients with short lower face heights tend to have a deep overbite at the end of treatment, whilst those patients with long lower face heights tend to have a reduced overbite. In *Fig.* 2 tracings are shown of a patient with a low lower face height and a large increase in overjet. The prognosis for this type of patient is good, because at the termination of treatment there is a deep overbite and considerable coverage of the upper incisor by the lower lip. The lower lip in this particular case caused a further retraction of the upper incisors following the withdrawal of a retention appliance and resulted in a typical Class II, division 2 incisal relationship.

Where there is a long lower face height and an increase in overjet, the prognosis is very much poorer because at the end of treatment the upper incisors are not controlled by the lower lip.

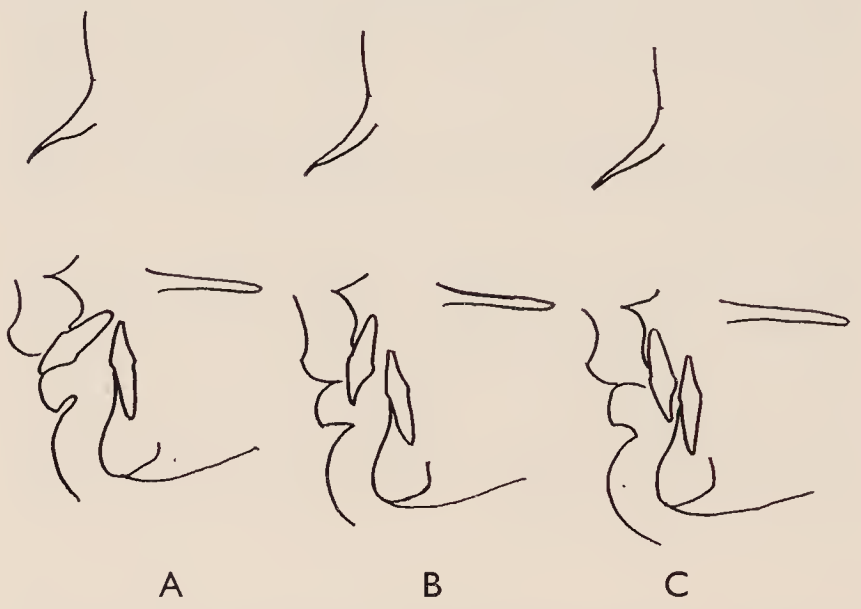

Fig. 2.—Tracings of cephalometric radiographs of a patient with a low lower face height and a large increase in overjet, who had received orthodontic treatment. A, Prior to treatment; B, At the withdrawal of the retention appliance; C, 3 years out of retention.

In the treatment of Class III patients an invariable finding is the reduction in overbite at the end of treatment. One of the factors which may contribute to this is the effect of proclination on the upper incisor being one of rotation about the midpoint of the root so that the movement of the incisal edge is upwards as well as forwards.

Table II.—Mean Measurements of Face and Incisor Height in Class II, division 1, Patients with complete and incomplete Overbites

	Lower Face Height	Upper Face Height	Lower Incisor Height	Upper Incisor Height
	Mean	*Mean*	*Mean*	*Mean*
Complete overbite	6·8	5·6	4·4	3·0
Incomplete overbite	7·4 $t = 6·2$ Significant difference at 5 per cent	5·2 $t = 4·3$ Significant difference at 5 per cent	4·35 $t = <1$ No significant difference	3·2 $t = 2·57$ Significant difference at 5 per cent

c. The Lower Incisor Segment

The lower incisor segment shows a marked tendency to achieve a similar degree of eruption in each type of malocclusion. The incisors, however, appear to be more stable in their position

and not so readily tilted by the soft tissues or by treatment. It is commonly supposed that in the gross Class III malocclusion the lower incisor segment lacking the contact of the upper incisors will overdevelop to an excessive degree. Lacking large numbers of such patients in the age-group which the author has investigated, it is not possible to apply statistical methods to this problem. There would not appear to be an overdevelopment in the incisor region in several cases examined, although an impression of overdevelopment may be given by the very short distance between the maxilla and mandible in the molar region of some of these patients.

The Lip Length in Children with Deep, Normal, and Anterior Open Bites.

An examination of the cephalometric radiographs showed that the number of children who held their lips together while the film was taken varied with each group. This probably does not represent the true degree of competence or incompetence, as a child cannot be said to be truly relaxed while being held firmly between the ears with the Frankfurt planes horizontal. There is, however, an interesting variation between each group which leads one to suppose that the degree of competence may vary with the lower face height.

Of the children with a deep overbite 23 held their lips together and 7 held them apart.

Of the children with a normal overbite 13 held their lips together and 17 apart.

Of the children with an anterior open bite 3 only held their lips together and 27 apart.

The length of the upper lip was measured from the base of the columella to the vermilion border by running an opisometer along the profile. The length of the lower lip was measured similarly from the vermilion border to the point of greatest convexity. In this way it was hoped that the skin length of the lip would be measured and differences in shape would be minimized.

There was no statistical difference between the lip lengths at the 5 per cent level using an analysis of variance (*Table III*).

It would appear that the lip length does not accommodate itself to the lower face height, which may be the reason why the degree of competence varies with the lower face height.

In patients with a deep overbite and lower face height there is in many cases a characteristic crease above the chin which is probably caused by the accommodation of a normal amount of lip tissue to a low lower face height (*Fig.* 1).

SUMMARY

Lateral skull radiographs were taken of three groups of children with deep overbite, normal overbite, and anterior open bite. There were 30 children aged between 12 and 14 years in each group. The lower face height was measured from the radiographs and was found to be statistically different at the 1 per cent level between each group. The vertical development of the upper and lower incisors was found to be not statistically different.

It is suggested that the lower face height controls the overbite. In the patients with a long lower face height there is a failure of the incisal segments to exceed the average development and therefore there is a reduced overbite or anterior open bite. In patients with a deep overbite, normal development of the incisors can take place leading to a deep overbite because the chisel shape of the incisors enables them to erupt past each other, uprighting in the process. The molar and premolar teeth, because of the interdigitation of the occlusal surfaces, cannot erupt past each other and therefore the growth of these segments is controlled by the relationship of the mandible to the maxilla. The ' kick-up ' of the lower incisors in deep overbite patients is often regarded as an overdevelopment of the incisors when it may be more properly regarded as a limitation of the development of the buccal segments.

Patients with an increased overjet and lower incisors biting on the palate (complete overbite) were compared with those where the lower incisors were biting off the palate (incomplete overbite). The lower face height of the incomplete overbite group was significantly longer than that of the complete overbite group. The lower incisor development was the same. The increased lower face height of the incomplete overbite

Table III.—Mean Profile Lip Lengths in Three Depths of Overbite

	Deep Overbite	Normal Overbite	Anterior Open Bite	
Lower lip	1·25 in.	1·25 in.	1·31 in.	$F = 2{\cdot}04$ No significant difference
Upper lip	0·59 in.	0·6 in.	1·61 in.	$F = <1$ No significant difference (F 5 per cent = 3·11)

group may be a factor in producing the incomplete overbite—an aetiology comparable to an anterior open bite.

The lip posture of children in the three groups of deep overbite, normal overbite, and anterior open bite was found to vary. In the deep overbite group 23 out of 30 held their lips together; in the normal overbite group 13 held them together; and in the anterior open bite group 3. The profile skin length of the upper and lower lips was measured with an opisometer to minimize any change in the shape of the lips of the three groups. There was no significant difference in the upper or lower lip lengths in the groups.

It would appear that the lip length does not accommodate itself to the face height in patients with a long lower face height, leading to a high percentage of incompetence and in the lower face height group to a folding or creasing of the lower lip.

Acknowledgement

The author wishes to acknowledge the work of Mr. C. Jones, Senior Lecturer of the Liverpool College of Technology, in producing the statistics for this paper.

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DISCUSSION

Mr. P. M. Benzies felt that one had to be very wary of statistical analysis and the author had to be certain of the nature and meaning of the results. Here one had a piece of research which could lead one to suspect that nothing could be done about the incisor teeth during treatment of all malocclusions, as it was argued that these teeth always slid past one another to attain their full natural alveolar height in spite of a good inclination to one another. Was this what Mr. Atherton wanted members to think?

Would facial height be influenced by anteroposterior changes in length, in addition to purely vertical components? What was the effect of soft tissues?

Mr. J. D. Atherton (in reply) said that the overbite was dependent upon the lower face height and therefore the facial pattern. As it was difficult to alter the facial pattern so it was difficult to alter the overbite. In patients with a low lower face height the incisors slide past each other to produce a deep overbite and in doing so became upright in inclination.

He had intended to avoid complicating the paper with a discussion on the anteroposterior relationship. The soft tissues were very important in determining the inclination of the teeth as was shown in the differing prognosis of Class II, division 1 patients with a low lower face height and long lower face height.

The President said that this was another nail in the coffin of soft-tissue function. They would have to concentrate more on morphology.

Mr. Atherton said that it was not meant to be a nail, but he thought that morphology had been neglected over the last few years.

Mr. D. A. Plint asked if he had perhaps missed any mention of the Frankfurt-mandidular or maxillary-mandibular-plane angle in relationship to the lower facial height?

Mr. J. D. Atherton (in reply) said that he had not commented on the maxillary-mandibular-plane angle. He had tried to keep his paper straightforward. He had stuck strictly to the lower face height. The low lower face height was usually associated with a lower maxillary mandibular angle, but not necessarily so. The anterior open bite was usually associated with a steep maxillary mandibular angle, but not necessarily so.

Mr. W. A. Nicol asked what were the difficulties involved in measuring upper incisor development when they were proclined or retroclined.

Mr. J. D. Atherton said that there was no satisfactory measurement for upper incisor development. The distance between the incisor edge and the anterior nasal spine in a patient with a proclined upper incisor was obviously much less than that in a patient with an upright central incisor. In the first part of the paper he had selected patients whose incisors were not markedly proclined.

Mr. L. H. Russell said that he had patients with low lower face heights with anterior open bites where there were tongue activities and sigmatism.

Mr. J. D. Atherton (in reply) said that such patients could exist in the lower age-group. His clinical experience was that by the age 12, taking the full permanent dentition, that type of patient appeared less frequently. They tended to stop thumb-sucking by this age. He had certainly taken that view in the patients selected. That was why he had chosen the group with a full permanent dentition, 12–14 years of age.

The President confirmed that, with a low lower face height, whatever the tongue was doing, there would still be a deep overbite.

Mr. L. H. Russell said that many of his patients were of Central European origin, with short lower face heights and bimaxillary proclination and open bite.

Mr. J. D. Atherton (in reply) said that the incisors were achieving their development if there was bimaxillary proclination. This was one of the cases that could be associated with a low lower face height.

One would tend to find bimaxillary proclination in negroes. They could not be compared with a white population. To a lesser extent it might be that central Europeans could not be compared with a British population.

RESEARCH REPORT

CINE-RADIOGRAPHIC STUDY OF TONGUE, HYOID BONE, AND MANDIBLE DURING DEGLUTITION.

By P. M. BENZIES, B.D.S., F.D.S., D.ORTH., R.C.S., D.D.O., R.F.P.S., Senior Registrar, Guy's Hospital.

THIS study consists of a cine X-ray film analysis of swallowing in twenty subjects having an ideal occlusion. A 35-mm. Arriflex camera with 180° shutter was used, and films were taken at 16 to 24 frames a second with a Philips 5 in. image intensifier. The subjects were given barium and glycerin to swallow, and were radiographed with a constant potential generator at 75 kV. In order to reduce the exposure of the subject to X-rays, a device operated by the shutter restricted X-rays to the actual period the film was exposed, which was approximately 10 seconds.

Skeletal Analysis

The twenty selected subjects were classified according to skeletal form, as follows: 5 Skeletal III, 7 slight Skeletal III, 5 Skeletal I, and 3 slight Skeletal II.

Analysis of Dental Relationship in Deglutition

On the evidence of the cine-radiographic film, 'normal' behaviour, with occlusion only at the mylohyoid contraction stage of swallowing, occurred in one subject. Three other subjects made tooth contact throughout the swallow. Four occluded their teeth after the bolus left the mouth. Twelve swallowed with teeth apart (7 wide apart and 5 slightly apart).

This agrees with Tulley (1962) that normal occlusion is more commonly found on a Skeletal III or slight Skeletal III base and that in such cases swallowing action may well take place with the teeth apart without any detriment to the occlusion.

Analysis of Hyoid Movement in Deglutition

The hyoid has three components of movement approximating to a triangle. The first is upwards, the second is forwards and the third returns the hyoid to its postural position. The sides of this triangle can be convexly curved, but this varies from case to case. The relative amount of hyoid movement alters with the skeletal relationship, there being more total movement in the subject with a Skeletal III pattern and progressively less in the slight Skeletal III, Skeletal I, and slight Skeletal II subjects.

There seems to be a relationship between the inclination of the lower incisors and the amount of hyoid movement. The more retroclined the lower incisors, the more total movement of the hyoid bone is seen.

A number of subjects with anterior open bite and tongue-thrust have been filmed and no obviously abnormal movements of the hyoid have been shown so far. They are in the range of movements already observed where a normal dentition is found with varying skeletal relationships. In these cases, however, the mandibular movements during deglutition were extensive in their compensating actions.

Acknowledgements

I wish to acknowledge and thank the Dental Council of Guy's Hospital for the grant which enabled me to carry out this research.

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Presented at the Research Meeting held in Plymouth on 21 May, 1964.

SYMPOSIUM ON FUNCTIONAL THERAPY

I. A SURVEY OF 100 CASES TREATED WITH THE ANDRESEN APPLIANCE

G. C. DICKSON, B.Ch.D., F.D.S., D.Orth. R.C.S.

Wessex Regional Hospital Board

I HAD for a long time been intending to carry out a survey of my cases treated with the Andresen appliance and accordingly I welcomed your Council's invitation to take part in this symposium as the necessary spur to make me proceed with it. Clinical impressions are notoriously unreliable, but I had never realized just how inaccurate they could be until I surveyed these cases.

As Moyers (1964) has pointed out, what we need to know is how to select the cases most suitable for treatment with this appliance. An examination of the literature revealed a number of papers concerned with modifications of the appliance. The only reference I could find which was at all clear regarding the selection of cases was by Hovell (1962). His results can be summarized as follows:—

Age: Best results were obtained in the mixed dentition.

Succeeds best in Class II, division 1 cases with proclined upper incisors but where the lower incisors are vertical and spaced or, at least, not crowded and where there is firm soft-tissue patterning.

He found the Skeletal pattern to be of no importance and frequently used the appliance where overcrowding necessitated the removal of four first premolars.

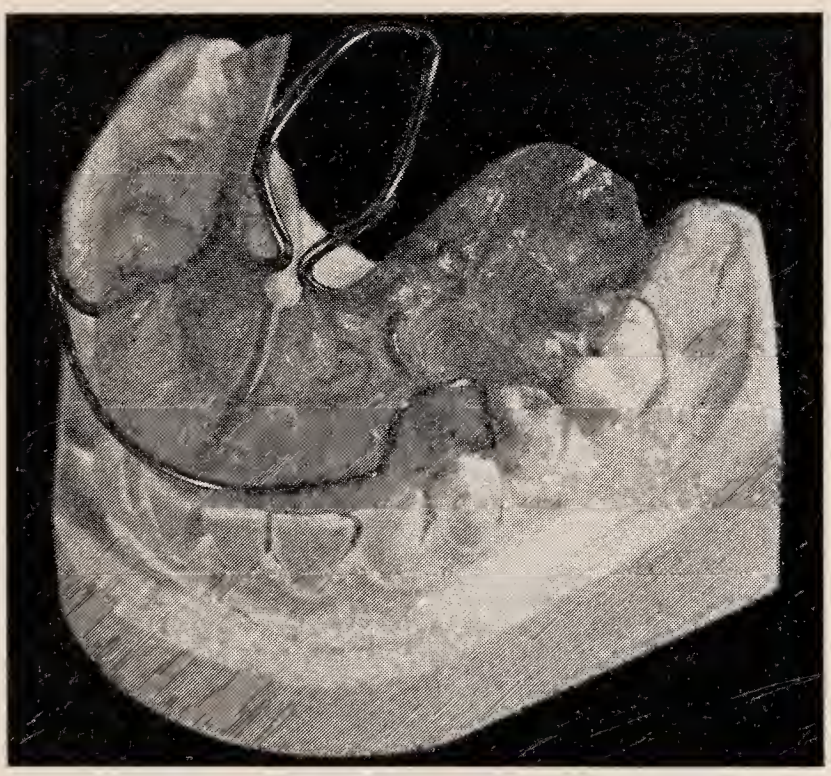

Fig. 1.—The 'standard' appliance used in the survey.

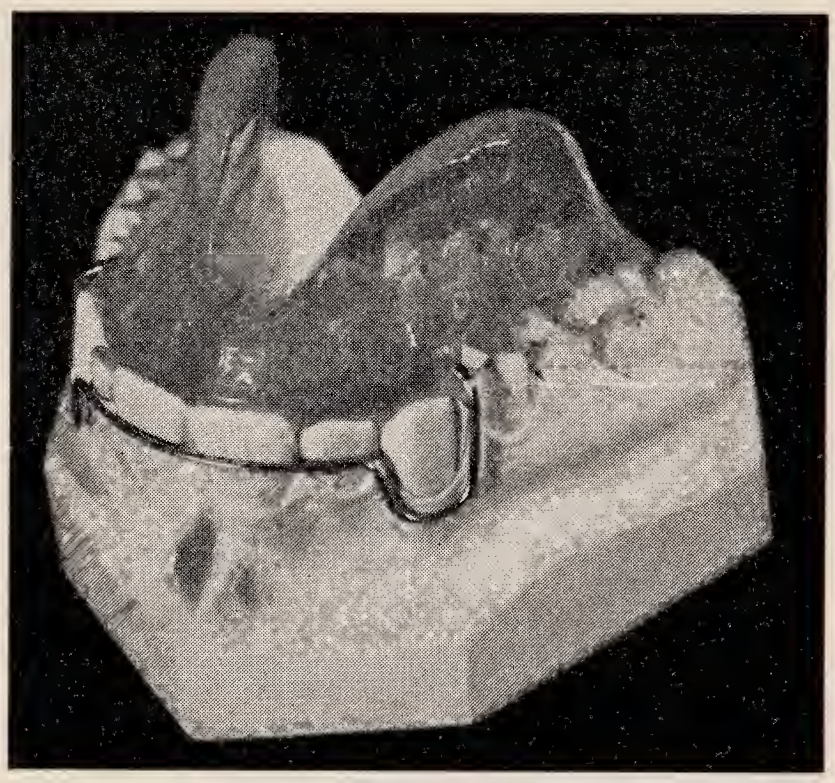

Fig. 2.—The appliance seated on upper model to demonstrate the deep lower lingual flanges.

Before embarking on the details I should make it clear that the survey has been confined to Class II, division 1 cases as this is almost the only type in which I now use this appliance. As its form differs slightly from the standard pattern described in this country by Endicott, Pedley, and Grossman (1947) I will first illustrate these differences (*Figs.* 1, 2).

The lower periphery is modified by extending the lower lingual flanges as deeply as possible and leaving them thick and rounded; this makes

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it necessary for the patient to open his mouth very wide to insert the appliance—and equally wide to take it out! Anteriorly, the periphery rises to a level about halfway up the lingual surfaces of the lower incisors so that the forward pressure is directed on to the teeth and not the soft tissue. Lastly, the appliance is always divided and the two halves united by a Coffin spring. Not only does this give some flexibility in operation such as the expansion of the upper premolar region usually thought to be necessary with Class II traction, but it removes the necessity for easing the posterior undercuts before inserting the appliance.

Fig. 3.—Age distribution of the patients surveyed.

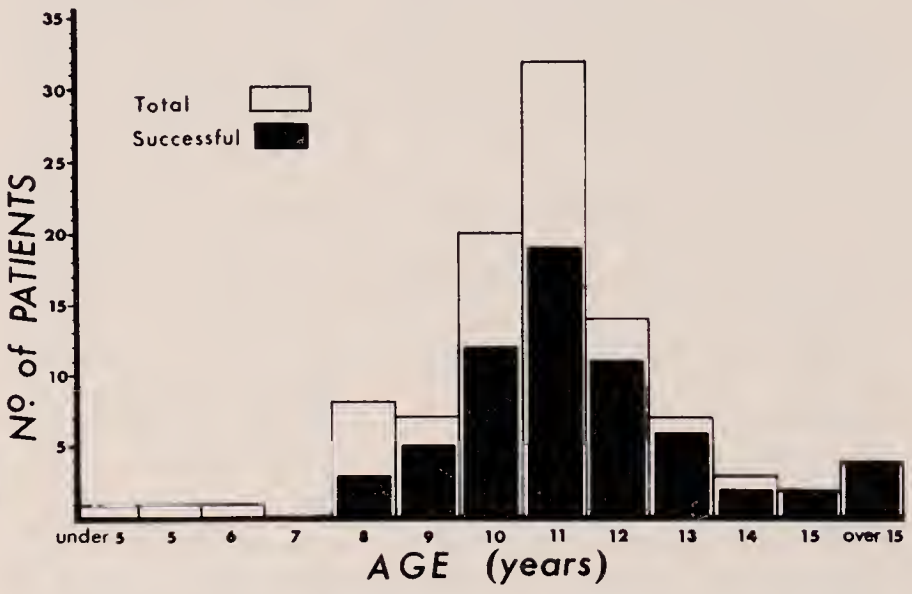

Fig. 4.—The relationship of age to treatment success.

This is the appliance as I use it; I realize that others may find these modifications quite unnecessary and they are described only to qualify the results of the survey.

One hundred consecutive completed cases were analysed and the following points noted:—

Age
Sex
Skeletal pattern
Lip competence
Swallowing pattern
Severity of overjet
Result of treatment
Duration of treatment
Co-operation of patient.

I have chosen to present the results in the form of histograms as I find this to be the easiest way to understand numbers quickly.

I will not discuss the factors which were responsible for the initial selection of patients except to say that loss of all first permanent molars (11 cases) was one reason for preferring this to other forms of intermaxillary traction and that in a smaller number (8) the appliance was made as a form of retention after completing tooth movement with fixed appliances. In 7 cases one or more premolars had been extracted. In 4 cases extra-oral traction was added to the appliance and 3 patients had more than one Andresen appliance. In 8 cases other appliances, either fixed or removable, were worn before or after the Andresen appliance as part of the treatment plan. In general, patients whose lower incisors were proclined or crowded were not selected for treatment with this appliance. As it is my normal practice to see patients wearing Andresen appliances at three-monthly intervals this appliance was often used for patients who for geographic and other reasons were unable to attend at frequent intervals.

The age distribution is shown in *Fig.* 3, the greatest number of patients being in the 11-year age-group. The ages refer to the year in which

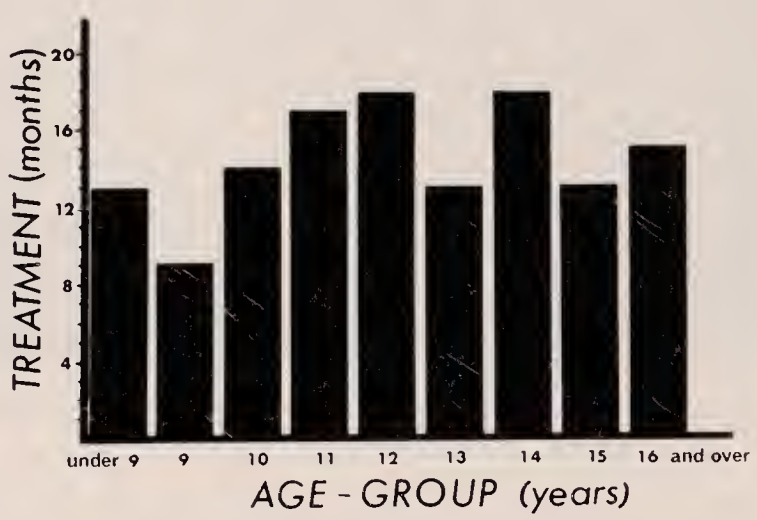

Fig. 5.—The duration of treatment related to age-group.

treatment was commenced, i.e., 11 years means that treatment was commenced between the eleventh and twelfth birthdays so the average age would be $11\frac{1}{2}$ years.

I was astounded by the number of failures. The vast majority of these were lost as wastage—the patient failed to keep appointments and so had not been my direct concern. I had not, therefore, been fully aware of this problem. Almost all the very young patients had failed whilst none of those of 15 years or over had

done so. Clearly a much closer selection of the *type* of patient is indicated. In all, 26 per cent of patients failed to complete treatment, 17 per cent having discharged themselves.

The cases in which the objectives of treatment had been attained numbered 65. Five more results were classified as ' moderate ' and 4 as ' poor ', though they showed some improvement.

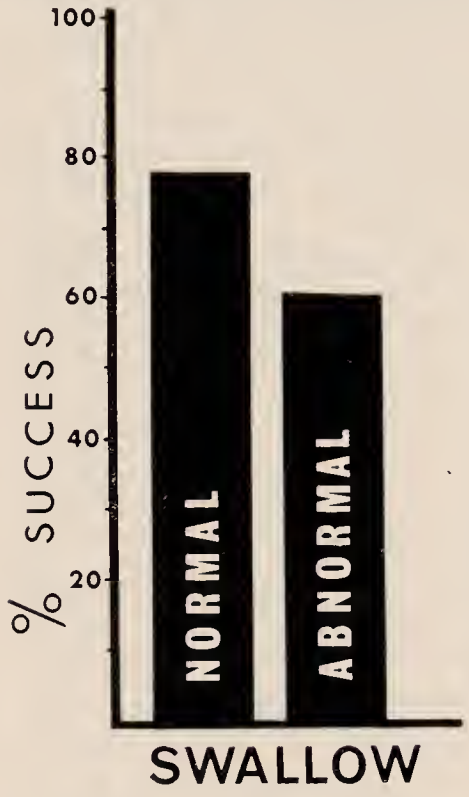

Fig. 6.—The relationship of swallowing pattern to successful treatment.

Fig. 7.—The relationship of overjet to successful treatment.

Fig. 8.—The relationship of patients sex to successful treatment.

Fig. 9.—The effect of skeletal pattern to success rate.

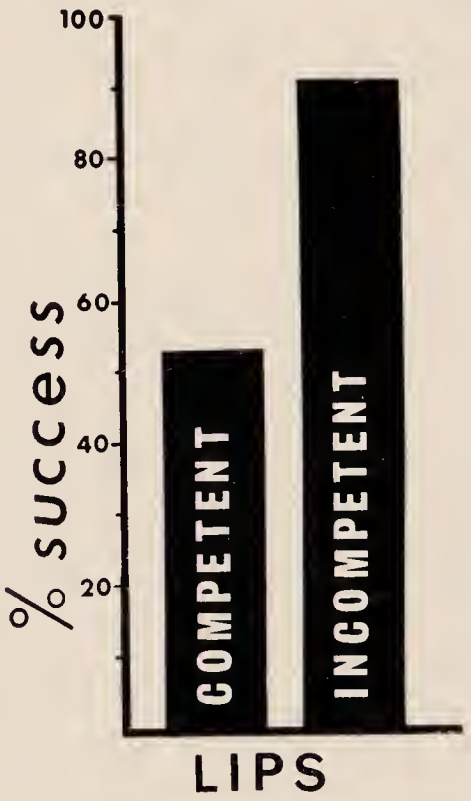

Fig. 10.—The relationship of lip competence to successful treatment.

The age distribution is shown in *Fig.* 4 from which it is clearly apparent that the older age-groups were much more successful.

The average duration of treatment was 15 months in the successful cases, the longest being 48 months and the shortest 5 months. When averaged within the age-groups the results, shown in *Fig.* 5, tended to show slightly longer treatments in the 11 to 14-year age-groups; the difference was not such as to have any clinical significance.

Of the patients with noticeably abnormal patterns of swallowing 60 per cent were successful against 78 per cent of those with normal swallowing patterns (*Fig.* 6).

The patients were divided into those whose overjet was described as severe, average, or mild, the middle group corresponding with an overjet of 7 to 11 mm. and the others were greater or less than this. As *Fig.* 7 shows, those with a relatively small increase of overjet were very successful indeed whilst those with a severe

overjet were much less so. There are two factors involved here: there is the obvious one of the malocclusion itself and the less obvious one that I am not normally very willing to undertake treatment of these cases at all, preferring to use my limited time for removing some of the more acute malocclusions from my waiting list. Such patients must therefore be very keen and insistent on treatment in the first place—and here I think is perhaps the most important factor in using this type of appliance.

I had a clinical impression that the girls were more concerned with their appearance and therefore co-operated better than the boys with this appliance, but the figures clearly showed that this was quite unfounded (*Fig.* 8).

Leaving out the borderline cases the Skeletal I cases were slightly more successful than the Skeletal II cases, but the difference was not significant, this bearing out Hovell's findings (*Fig.* 9).

Assessment of the lip competence produced what was to me a surprising result. Whereas the patients with competent lips had a success rate of only 58 per cent, those with incompetent lips had the remarkable success rate of 93 per cent (*Fig.* 10). I will not comment here on this except to say that such patients usually have a strongly active lower lip.

SUMMARY

Summing up, the cases which responded *best* to treatment were aged 14 years or over and had mild Class II, division 1 malocclusions and incompetent lips and with a slight preference for a Skeletal I dental base relationship.

I would like to stress that this survey was of necessity limited to my own patients, which imposes a highly personal factor on the selection of cases, and that its scope was limited by my method of recording clinical data. I hope eventually to extend it to include other factors and to present a fuller and more discursive paper to this Society in due course.

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II. THE ACTIVATOR IN CLASS II MALOCCLUSION

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FUNCTIONAL jaw orthopaedics has now been practised for over forty years and we are now able to see much clearer its advantages and shortcomings. The activator is a powerful form of intermaxillary traction—a muscle educator and a functional stimulator able to produce the bony changes necessary for individual tooth movement.

The activator is only one type of many different forms of orthodontic appliance. Functional jaw orthopaedics does not claim success in every case, nor is it suitable for every case. It is successful only if the operator uses this method judiciously and, above all, has been properly trained in its use. One of the appliance's main enemies is the apparent simplicity which has tempted many untrained to use it. It was only to be expected that their results were poor. In the mid-thirties, Schwarz (1939a) and other continental schools were strongly opposed to the activator—ten years later Schwarz (1939b) and others became their staunchest supporters. Histological work, like Reitan's (1951), contributed a lot to the disagreement over advantage of functional stimulation. The fact remains that the original histological work by Haupl and Psansky (1938, 1939) is still the only valid one on this particular subject.

Those of us who have used this method for over thirty-five years do not claim like other 'orthodontic philosophers' that our method is infallible or the only type of appliance to be used, but I firmly believe that the activator is, for certain types of malocclusions, the only one which can be used successfully. For cases in need of complicated individual tooth movement, it is obviously not the appliance of choice. Functional orthopaedics can be used in a variety of selected cases, but, due to the limited time, I shall restrict myself to Class II malocclusions.

SELECTION OF CASES

Class II, Division 1

The case suitable should have good dental arches; there must be no upper anterior crowding. This I consider a definite contra-indication. If the patient is asked to bring the mandible forward, the dental arches must be able to come into good occlusal relationship. Jackson (1947) in one of his papers spoke of the bite of 'optimum occlusal

relation'. This type of relationship must be obtainable. We see sometimes cases of Class II, division 1 where we are unable to produce this due to incisor interference. These cases should be left well alone by those less experienced in this method. Interference by individual teeth like narrow intercanine spaces need preferably previous active treatment. One factor which must be borne in mind is the profile of the child. Children with severely retruding chins where the incisors are relatively forward of the chin point need careful assessment. Any further forward movement of the incisors by intermaxillary traction will leave the chin point still further behind, and consequently result in an undesirable change in profile configuration. It has been stated that lower anterior crowding follows the treatment by activator, but we have seen far more severe crowding in cases treated by extraction of two upper premolars, therefore we are not concerned about the crowding we have seen following activator treatment. It is true it occurs sometimes at the age of 15 years or later, but the same we see in normal cases which have had no treatment at all. A further help in the prognosis of Class II, division 1 cases has been suggested by Rakosi (1960). He studied the mandibular movement from freeway space into centric occlusion not only clinically but also from cephalometric tracings. He found that during closure some cases moved into a forward position—some into a distal position. Most, of course, moved in a straight hinge movement. Those which moved responded, on the whole, only in a very limited way to functional therapy, and he considers that those cases represent the well-established unchangeable Class II pattern. In those where the closing movement results in a distal movement of the mandible, the results were satisfactory. The explanation may be that occlusal or other environmental factors have interfered with normal forward development of the mandible. In a small group of cases assessed by electromyograph we found that cases showing at the beginning of treatment a true distal displacement of the mandible responded, no doubt, much better to functional jaw orthopaedics than those which have a forward bite at the onset. The change of the mandibular position from freeway space to centric occlusion is rather difficult to assess clinically; cephalometric and electromyograph examination is essential to diagnose them.

Class II, Division 2

In Class II, division 2 treatment with functional jaw orthopaedics should start at the age of approximately 7 years. If the laterals are overlapping the centrals considerably, we extract $\underline{C|C}$, insert an activator with guiding wires to $\underline{2|2}$, and holding wires to the first molars to prevent a slipping of the appliance during the night. The activator has an expansion screw to allow regular adjustments. After $\underline{2|2}$ are moved sufficiently to free the centrals, gutta percha is used to move $\underline{1|1}$ forward, followed later by gutta percha to $\underline{\overline{21|12}}$. During successful treatment it will soon be seen that the 6-year molars erupt fairly fast, resulting in what appears to be a submerging of the deciduous molars. After alinement of the front there is no lack of space for the permanent canines, due to the massive premaxilla, a characteristic of the Class II, division 2. The cephalometrics show quite a different growth pattern in these cases compared with Class II, division 1. The first part of Class II, division 2 treatment, the alinement of the incisors, can be more quickly obtained by an active plate followed later by functional jaw orthopaedics. In the permanent dentition treatment of Class II, division 2 with the activator is difficult and only advisable in well-selected cases.

BITE TAKING

One of the most important steps in the making of an activator is the correct and individually most advantageous working bite. It is the change in the maxillomandibular relationship with the simultaneous activation of the masticatory muscles which will produce the functional stimulation which will be transferred via the loose appliance on to the teeth and parodontal structures and temporomandibular joint. *The bite taking has changed* since the first publication of the book by Andresen, Haupl, and Petrik (1957) and I, therefore, wish to discuss this in more detail. The working bite will hold the mandible in a different position from its individual norm. The different position can affect three directions, e.g.:—

a. Vertical position.
b. Antero-posterior position.
c. Transverse position.

In cases of Class I with upper protrusion and deep overbite, and in Angle Class II, division 2 cases of the inverted anterior overbite, it is essential to achieve the right vertical opening by assessing the relationship of the upper incisal edges to the lowers and not by interocclusal space in the buccal segments. An Angle Class II, division 2, Skeletal I and II, or in postural Class III, the incisal edges should be $1\frac{1}{2}$–3 mm. apart. The extent of the individual overbite determines the opening. In Class II, division 2 in the mixed dentition, the opening in the premolar regions should then be not more than 4–7 mm. In the permanent dentition in this type of case 9 mm. or more will be well tolerated. The reason that there is no pain or temporomandibular joint complaints is due to the fact that this type of case needs, on the whole, very little forward displacement of the mandible in the working bite, usually not more than one half unit. The activation of the muscles occurs by the opening of the

bite only to a minor degree by changing the relationship.

In Angle Class II, division 1 the opening of the bite depends on the amount of forward movement of the mandible during the bite taking. If only little forward movement of the mandible is necessary, the bite opening should be greater to achieve the necessary muscle activity. In cases of marked Class II, division 1 the opening in front between the incisal edges can be 1–4 mm., depending on the opening between the occlusal surfaces in the premolar region which must not exceed 7 mm. Those observations have to be kept well in mind, particularly when the curve of Spee is exaggerated. As the curve of Spee becomes less pronounced the bite can be opened further.

In cases of anterior open bite where the plate is not filed out in the buccal region, opening in the premolar region can be as little as 2–3 mm., particularly if the activator is used in combination with a chin cap and vertical traction.

The age of the child, too, has to be considered. In young children (early mixed dentition) the opening in the premolar region should be not more than 4 mm.; later 7 mm. will be well tolerated.

Finally, cases where expansion screws are used and the occlusal relief is left for better retention, the bite opening should be lower (4 mm.) than usual as the patient has a tendency to chew those plates and consequently increases already his muscle activity. Also, when the screw is opened, we find that the teeth no longer fit so well into the occlusal relief of the plate, resulting in a further bite opening.

Sagittal Direction

During opening of the bite the lower dental arch assumes a distal relationship. In cases of Class I where no mesiodistal changes are necessary, one has to make sure that during the bite taking the mandible comes sufficiently forward to bring both arches into neutro-occlusion (this usually means half a unit forward displacement). In Class II, division 1 our old idea of moving the mandible forward in stages we no longer adhere to, but bring the mandible into a position of neutro-occlusion in one step. This can, however, only be done if there is no individual tooth interference of narrow upper arches where a diminished intercanine space would prevent this or a collapsed upper arch would lead to a cross-bite. Preliminary orthodontic treatment is necessary in those cases. Class II, division 2 forward movement has to be done in stages as the upper retroclinated incisors do not allow full adjustment. The upper and lower incisors should be in one perpendicular line but not more as it otherwise may be seen that the patient keeps his lower incisors in front of his uppers, creating an inverted overbite which leads to further retraction of the uppers. To assess the correct maxillo-mandibular relationship, we use in the mixed dentition the relationship of the upper deciduous canines to the lower, and, in the permanent dentition, the upper first premolar to the lower first and second premolar. (This applies particularly to the final appliance where we find exact occlusal relationship has to be obtained.)

The upper deciduous canines should point at contact point of lower deciduous canine and first molar, and in the permanent dentition, the buccal cusp of upper first premolar should point to contact point of lower first and second premolars.

Transverse Direction

If no changes in transverse direction are desirable, great care must be taken to see that upper and lower midline correspond.

We can, for diagnostic and prognostic purposes, divide our malocclusions into two groups:—

1. Functionally adapted true malocclusion. The neuromuscular pattern is in accordance with the morphological anomaly and has consequently a rest position and centric occlusion typical for this abnormality.

2. Functional non-adapted malocclusions where the neuromuscular pattern is not adapted and not in accordance with the malocclusion, which means that in the rest position the mandibular position is correct but during closure and centric occlusion is abnormally placed.

For therapeutic purposes this means that we have two groups. True-inherited malocclusion where the morphology and neuromuscular pattern are functionally fully adapted—if submitted to orthodontic therapy, this will result in an improvement of the occlusal relationship but leave an unphysiological neuromuscular pattern which may or may not become adapted.

Into the second group fall those morphological variations to which the neuromuscular patterns are not adapted at the beginning and where orthodontic treatment will only create an occlusion in accordance with the existing neuromuscular pattern.

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III. CASE REPORTS

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My contribution to this symposium is, perhaps, that of Devil's Advocate. I have, in the past, used the Andresen appliance to treat many types of malocclusion, although never as widely as some of my colleagues. I have never found it successful in the relief of crowding nor in the elimination of tongue-thrusting and thumb-sucking. I have achieved successes in cases of vertical relationship of the jaws—that is, a mandibular angle within normal limits. The lips may be incompetent, often with the lower lip resting under the upper incisors, but there should not be any major abnormality of the soft tissues. The upper incisors will probably be proclined, and it is an advantage if the lower incisors are also proclined. The overbite should be complete

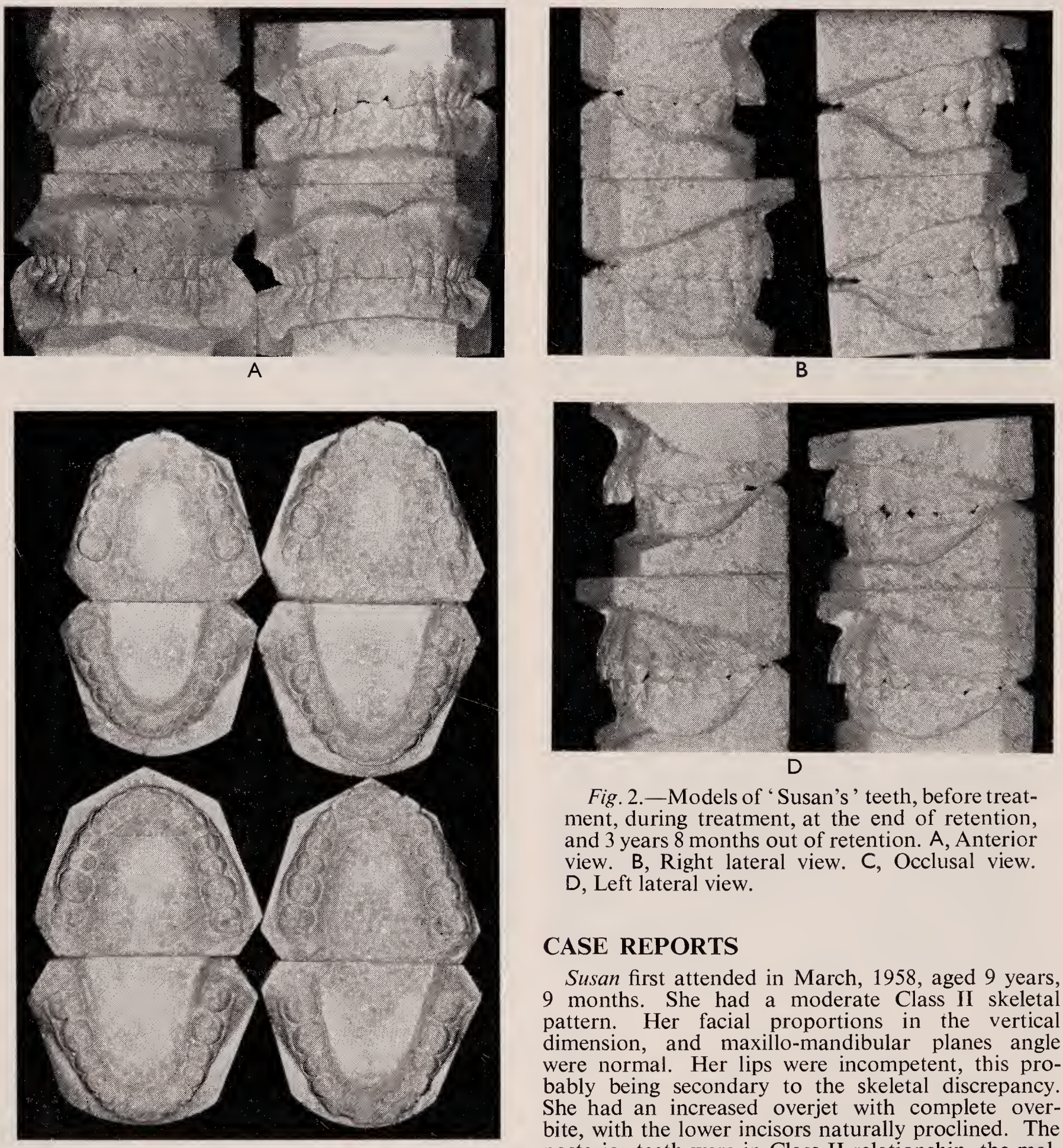
Fig. 1.—Photographs of ' Susan ' taken before and after treatment. A, With lips at rest. B, With lips held together.

Angle Class II, division 2, and Class III malocclusion, but I believe that I now know methods which produce equally good results more certainly and more easily in these types of malocclusion. I find it the appliance of choice in one, rather uncommon, type of Class II, division 1 malocclusion.

Such a case should, ideally, have a Class I to moderate Class II skeletal pattern, with a normal or only slightly incomplete; any tendency to open bite often tends to worsen during treatment. Most important, the dental bases should be long, with no tendency to crowding in either arch; if the lower arch is spaced, so much the better. There will be an increased overjet, and Class II molar relation.

To illustrate my point, I examined the records of a group of patients treated by postgraduate

students under my supervision at the Eastman Dental Hospital, London, and whose treatment was considered complete in 1961 or 1962. At this time they would be out of retention for 12 months, so it would be possible to obtain records showing the condition between 2 and 4 years out of retention. There were 109 patients in this group, of whom 28 fell into Angle Class II, division 1. Six of these were treated with the Andresen appliance. One of these patients did not co-operate, and after 6 months we changed to other appliances, with which we achieved an acceptable result. I make it a rule not to persevere with this type of appliance for longer than 6 months if definite progress is not apparent. I propose now to present the remaining 5 cases, which will therefore present a small unselected sample. I shall present one case in some detail, and the remainder more briefly.



A B C D

Fig. 2.—Models of 'Susan's' teeth, before treatment, during treatment, at the end of retention, and 3 years 8 months out of retention. A, Anterior view. B, Right lateral view. C, Occlusal view. D, Left lateral view.

CASE REPORTS

Susan first attended in March, 1958, aged 9 years, 9 months. She had a moderate Class II skeletal pattern. Her facial proportions in the vertical dimension, and maxillo-mandibular planes angle were normal. Her lips were incompetent, this probably being secondary to the skeletal discrepancy. She had an increased overjet with complete overbite, with the lower incisors naturally proclined. The posterior teeth were in Class II relationship, the malocclusion being apparently solely due to the skeletal discrepancy. The dental bases were long, with no suggestion of crowding.

When first seen she had a mixed dentition, and treatment was deferred until all the permanent antemolar teeth were present. Although treatment may be commenced in the mixed dentition, I find that it is

more quickly completed in the complete permanent dentition, with consequent conservation of patient co-operation!

An Andresen appliance was inserted in July, 1958, and worn for 11 months until July, 1959, when a second similar plate was constructed, with the mandible somewhat further protruded. This was worn until November, 1959, when the occlusion was normal. The patient was then instructed to wear the appliance for three nights per week until May, 1960, when it was discarded. The treatment time was 16 months, followed by 6 months' retention.

Fig. 1 shows the patient before and after treatment. In *Fig.* 1A she appears with her lips at rest; since they are incompetent, they are slightly apart in this photograph. In *Fig.* 1B they are held together as a result of a conscious effort by the patient. In both cases they are essentially unchanged after treatment, although, in fact, she now usually makes the effort of holding her lips together, from an increasing interest in her appearance, whereas when we first saw her, they were usually apart.

Fig. 2 shows the models of the case. A gradual improvement is seen in the posterior occlusion during treatment, as shown in the upper right hand models in *Figs.* 2B and D; this is usually seen from the second month of treatment, and there is no sudden 'jumping of the bite'. The final models were taken 3 years 8 months out of retention, and it will be seen that there is mild crowding of the lower labial segment. This is an occasional finding with the Andresen appliance, as it is with other appliances or even in the untreated mouth.

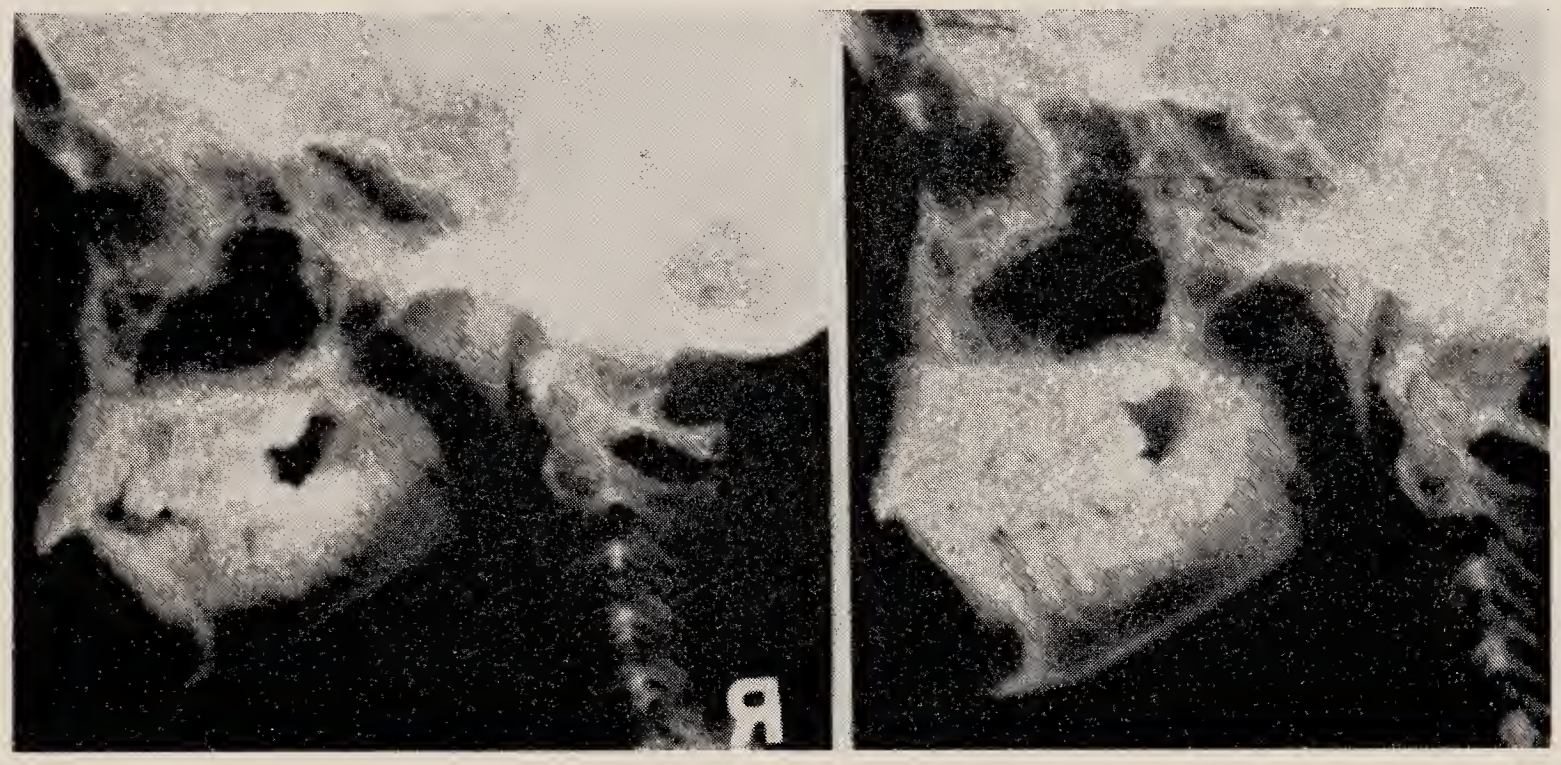


Fig. 3.—Lateral skull radiographs of 'Susan', taken before treatment and 3 years 8 months out of retention.

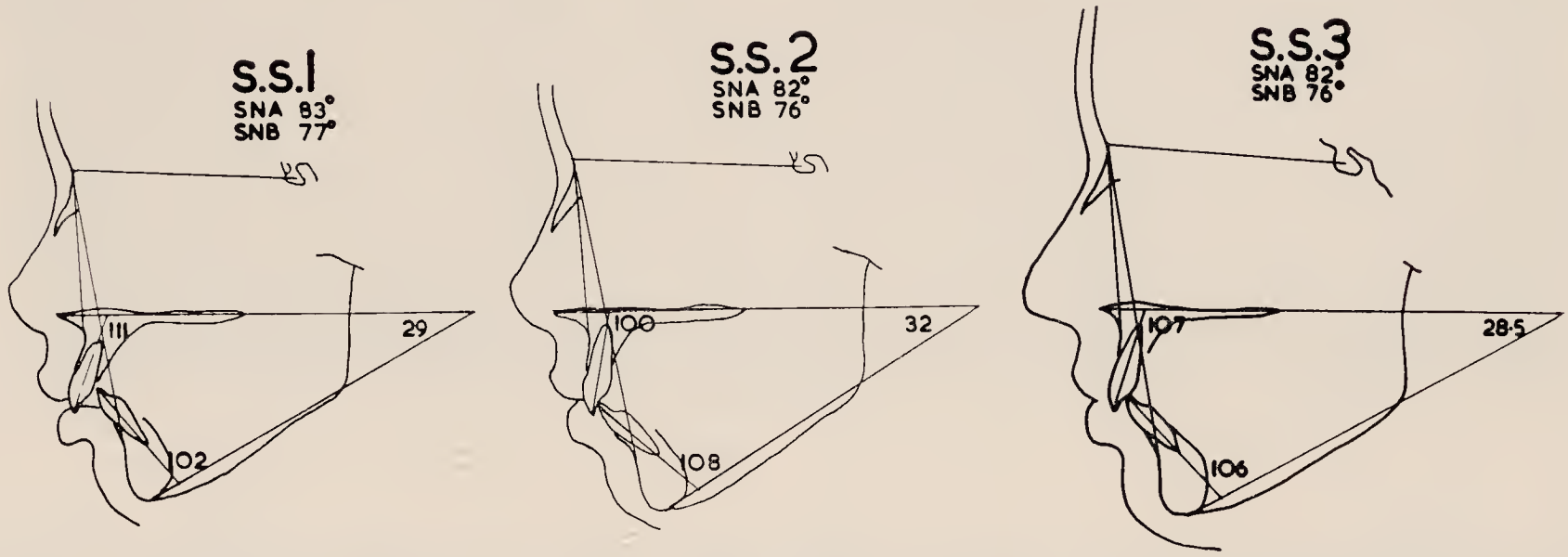


Fig. 4.—Tracings of radiographs of 'Susan' taken before treatment, at end of retention, and 3 years 8 months out of retention.

Fig. 3 shows the lateral skull radiographs before treatment and at the final visit. It will be seen that the dental bases are long with adequate room in the tuberosity of the maxilla and ascending ramus of the mandible for the developing molars, although even now, at 16 years, there is insufficient room for the third molars.

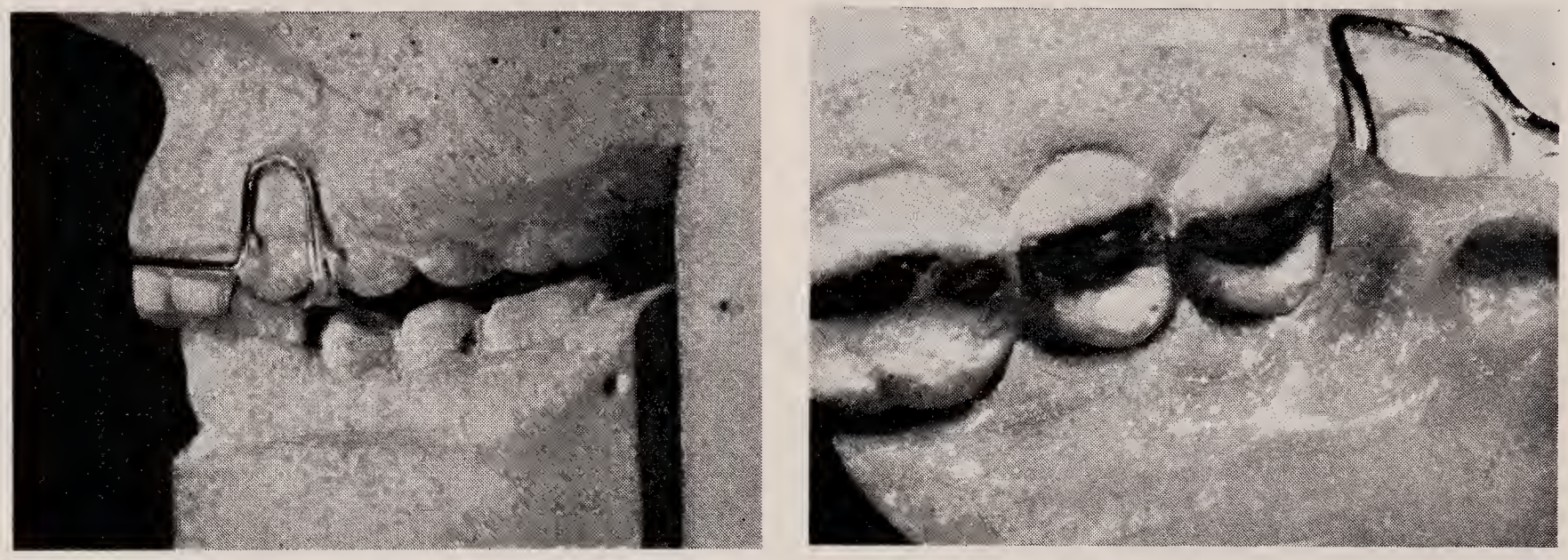
Finally, in *Fig.* 4, we see the tracings of the radiographs, taken before treatment, at the end of treatment, and 3 years 8 months out of retention. The difference between the angles SNA and SNB—the angle ANB—is 6°, which confirms the impression of a moderately severe Class II skeletal pattern. This relationship remains unchanged throughout. The maxillo-mandibular planes angle is normal. The

upper incisors, at 111° to the maxillary plane, were insignificantly different from the average for London schoolchildren quoted by Ballard (1956) as 109°. During treatment they retroclined to 100°, from which they settled to 107°. The lower incisors were initially naturally proclined at 102°. They did not change appreciably thereafter, despite the slight imbrication in the lower incisor region. The maxillomandibular planes angle opened slightly during treatment, a common finding during the use of intermaxillary traction, but returned to the original figure thereafter.

The changes were, therefore, similar to those found by Softley (1952); a combination of numerous small tooth movements. The upper teeth were tilted posteriorly, and the lowers anteriorly. The incisors were moved into a position where the lips would hold them together, whereas previously the lower lip had tended to keep them apart.

Fig. 5 shows details of the appliance used in the above case, and serves to illustrate my use of the appliance in general. It is constructed conventionally, as described by Haupl, Grossmann, and Clarkson (1952). The Andresen appliance is used for correction of post-normal relationship of otherwise ideal arches, and if other tooth movements are required, I prefer to correct these first with conventional appliances. Ideally, it should be constructed with the mandible protruded sufficiently to bring the canines into a Class I relationship, as shown in *Fig.* 5A. If, as is often the case, such a position would be strained or uncomfortable, a first appliance is made with the mandible protruded less than the optimum amount, a second appliance being constructed when some improvement has been achieved. This was necessary in four of the five cases described in this article. I would emphasize the importance of comfort in wearing the appliance; the mandible must be neither too far forward nor too far open.

The appliance is trimmed very thoroughly around the posterior teeth. The intervening acrylic is completely removed where it is desired to reduce the overbite, as shown in *Fig.* 5B, although a shelf of acrylic may be left between the upper and lower posterior teeth where overbite reduction is to be avoided. A spur of acrylic is left in contact with the mesial surface of the upper and distal surface of the lower cheek teeth, acrylic being freely removed on the remaining sides. The plate is not trimmed where it is in contact with the anterior teeth, until the last stages of treatment, when a little acrylic may be removed lingually to the upper incisors in some cases. There is a difference of opinion on the trimming of Andresen appliances, some operators leaving the appliance completely untrimmed. I believe that the posterior teeth move by tilting, and it would seem that this would occur more readily if the teeth were free to tilt than if they were held by a close-fitting splint.



A B

Fig. 5.—A, Andresen appliance mounted between ' Susan's ' models. B, With upper posterior teeth, to show method of trimming.

I now propose to report the remaining four cases more briefly:—

Paul (*Fig.* 6) was first seen in August, 1958, at the age of 11 years 5 months. He had a moderate Class II skeletal pattern, with both upper and lower incisors proclined, and the former resting on the lower lip. The lips were otherwise competent. There was an increased overjet with virtually complete overbite, and the posterior teeth were in Class II relation. The dental bases were long, although there was a suspicion of crowding in the incisor region.

A first Andresen appliance was fitted in September, 1958, and a second, with the mandible further protruded, in July, 1959. This was worn until February, 1960, and thereafter three nights per week, as a retainer, until May, 1960. Treatment time was 17 months, followed by 3 months' retention.

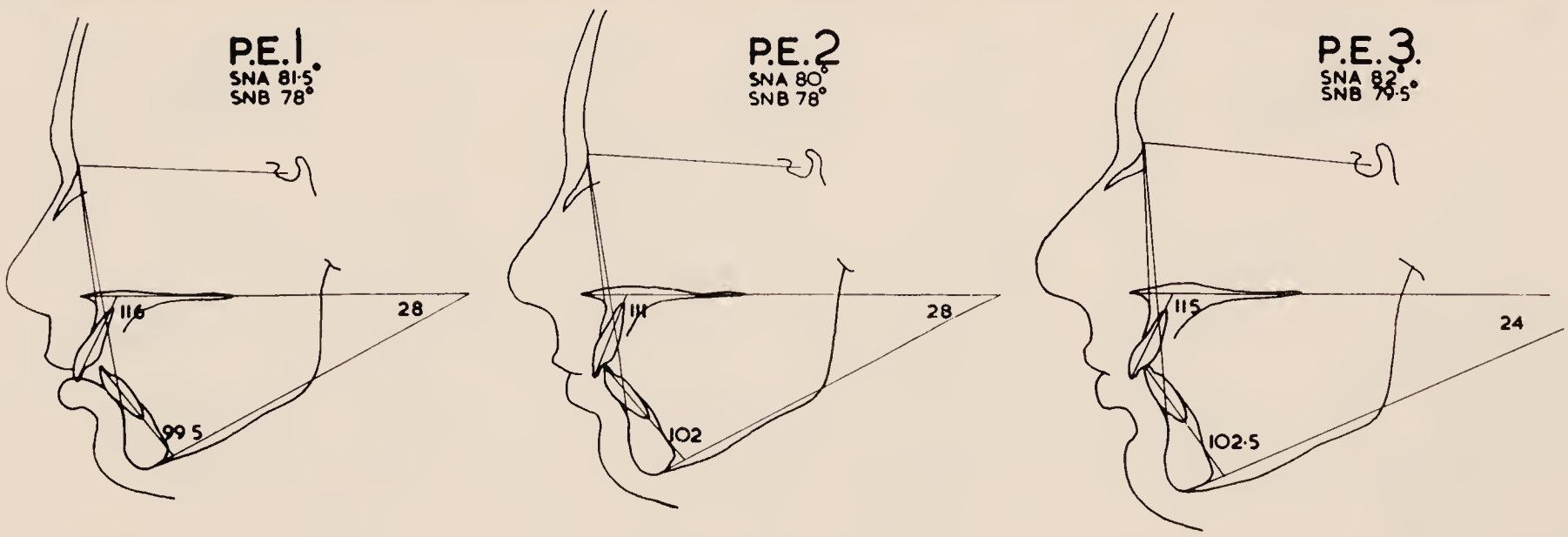
Fig. 6 shows records of the patient taken before treatment, at the end of retention, and 3 years 9 months out of retention. It will be seen from *Fig.* 6C that the angle ANB decreased by 1°, while the maxillomandibular planes angle decreased by 4°. The upper incisors were retroclined through 5°, although they later returned, almost to their original angle. The lower incisors were proclined through 5° and did not change. The result of treatment was again to move the incisors in to a position where the tongue and lips could hold them together, instead of holding them apart.

Corinne (*Fig.* 7) was first seen in May, 1958, at the age of 11 years 2 months. She had a mild Class II

skeletal pattern, with incompetent lips, and the lower lip trapping under the upper incisors. Both upper and lower incisors were proclined and spaced, with an increased overjet and complete overbite. The dental bases were long, with a general tendency to spacing, although locally $\overline{|5}$ was slightly crowded.

A

B

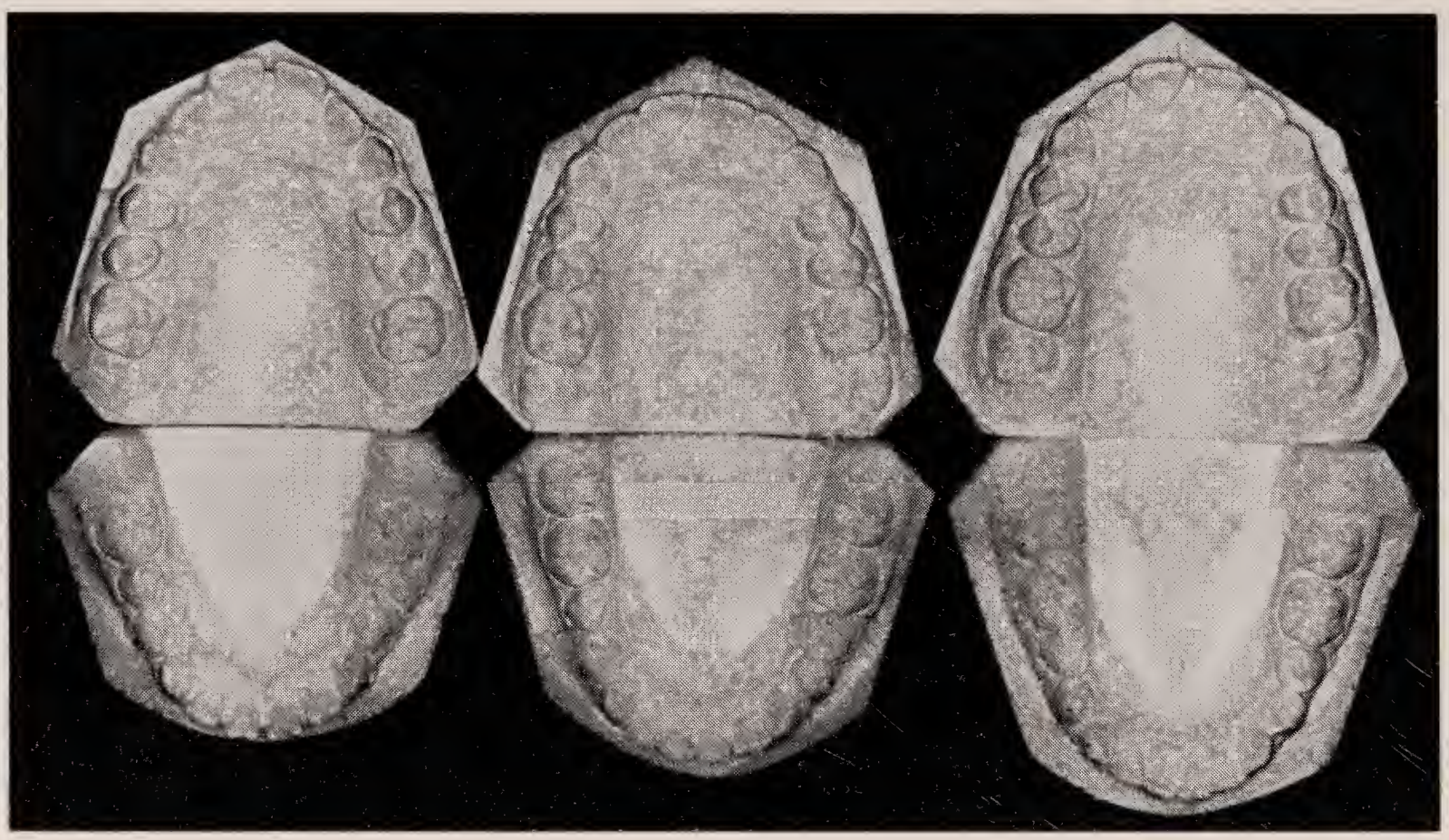


C

Fig. 6.—Records of treatment of ' Paul ' before treatment, at end of retention, and 3 years 9 months out of retention. A, Left lateral view of models. B, Occlusal view of models. C, Tracings of lateral photographs.

Again, two successive Andresen appliances were fitted, in July, 1958, and August, 1959, respectively. Contrary to my usual practice, the first appliance had a short spur of 0·5 mm. hard stainless-steel wire embedded in it in such a position as to rest in firm contact with the mesial surface of $\overline{|6}$. This spur gradually created sufficient space to aline $\overline{|5}$. By November, 1960, the posterior occlusion was normal, but the upper incisors remained proclined and spaced, with some overjet. A conventional upper removable

A



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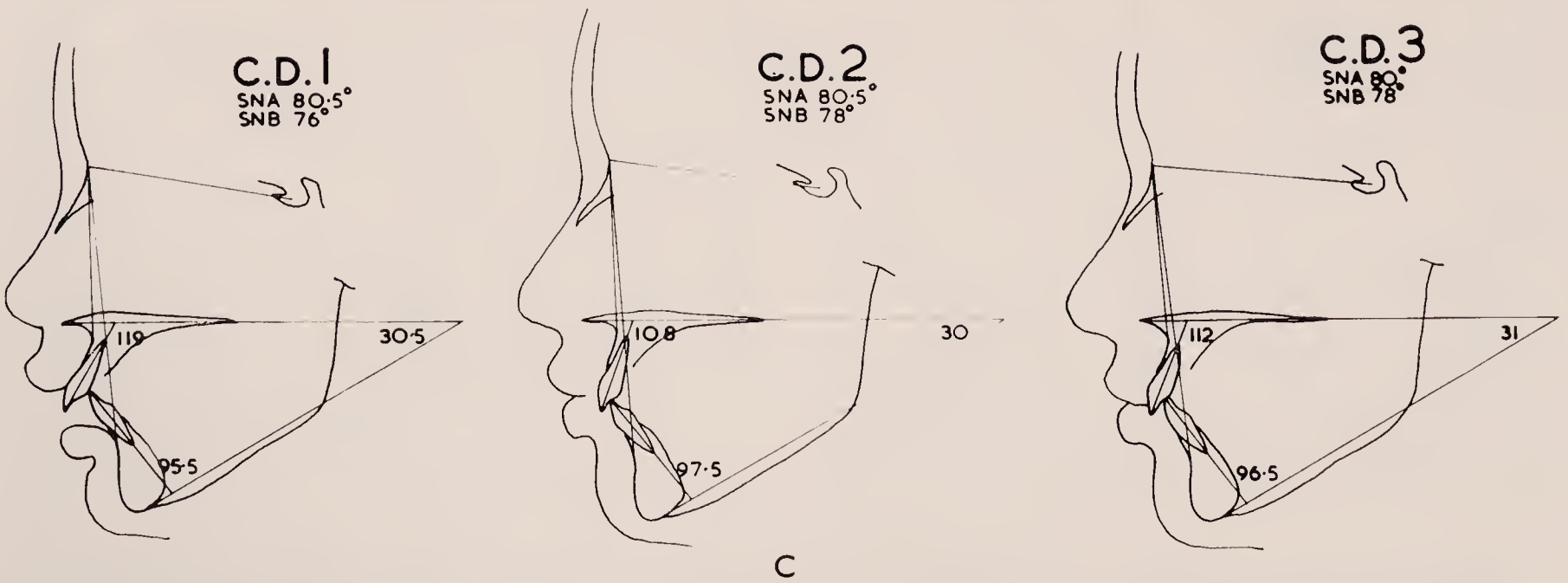
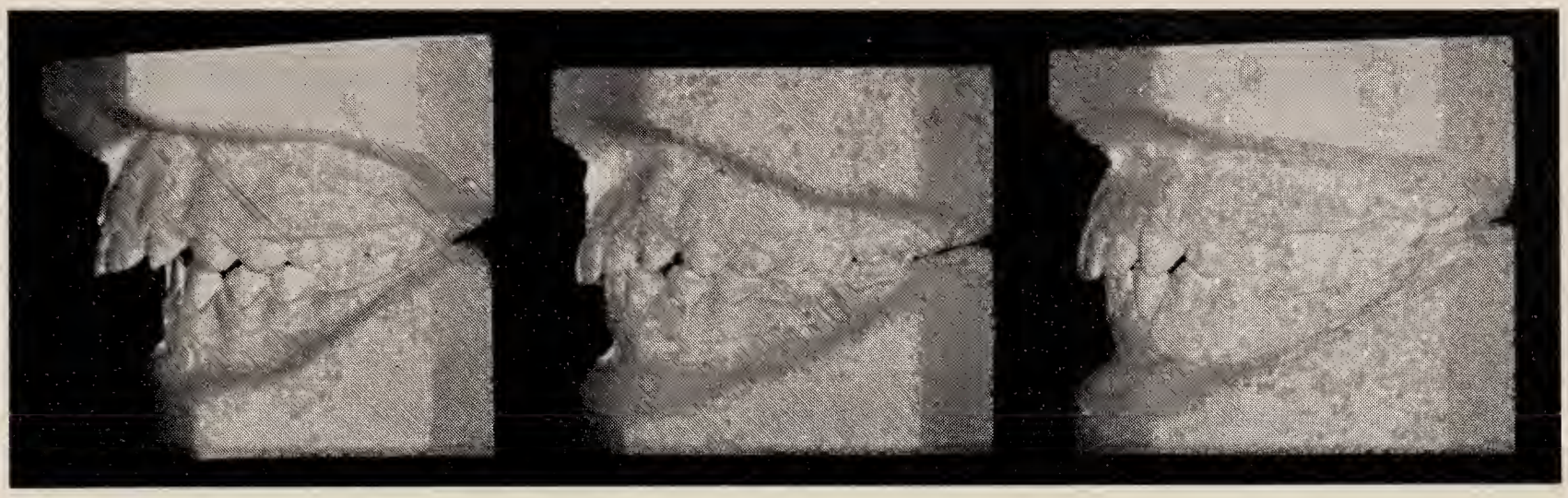


C

Fig. 7.—Records of ' Corinne ' before treatment, at end of retention, and 2 years 4 months out of retention. A, Left lateral view of models. B, Occlusal view of models. C, Tracings of lateral radiographs.

appliance was therefore fitted, instead of the Andresen appliance, to close these spaces and complete overbite reduction. The Andresen appliance is not ideal for closing anterior spacing in the upper arch, and it would probably have been better to have done this before fitting such an appliance. The conventional



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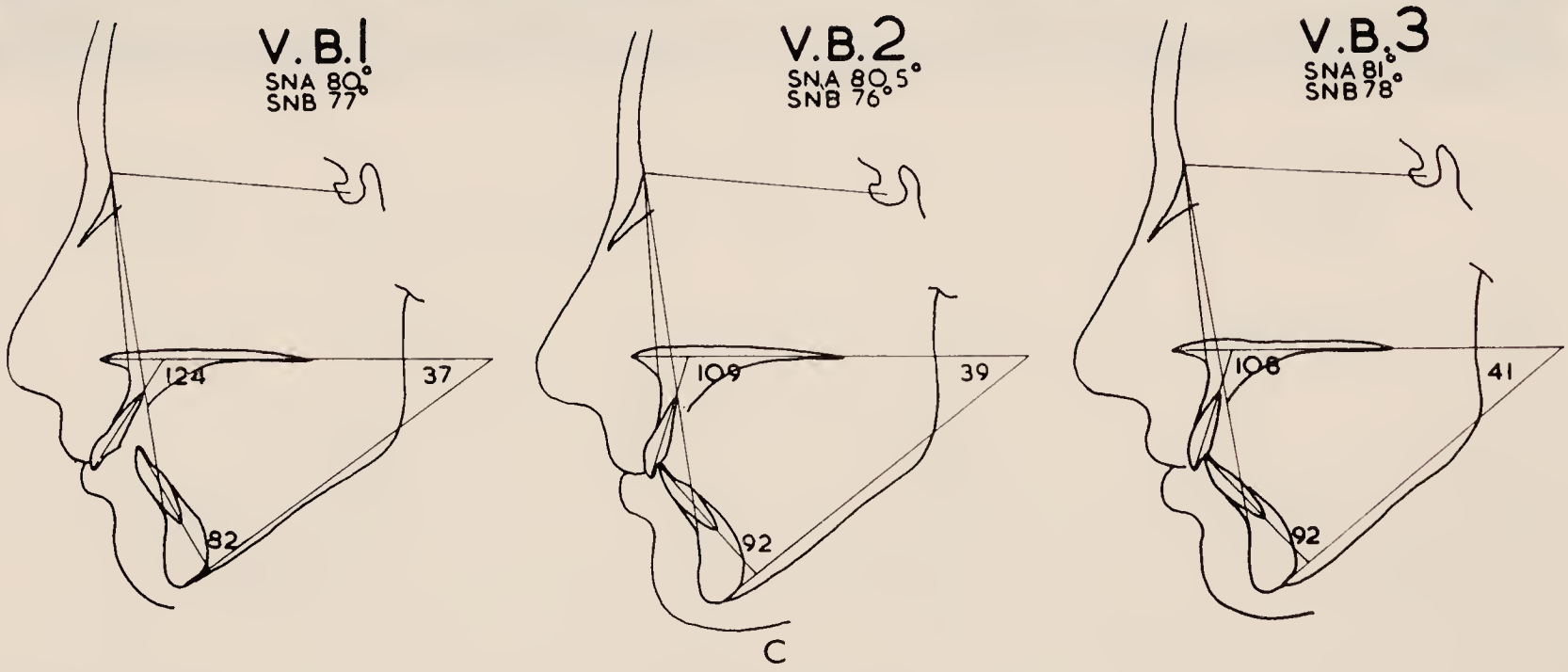
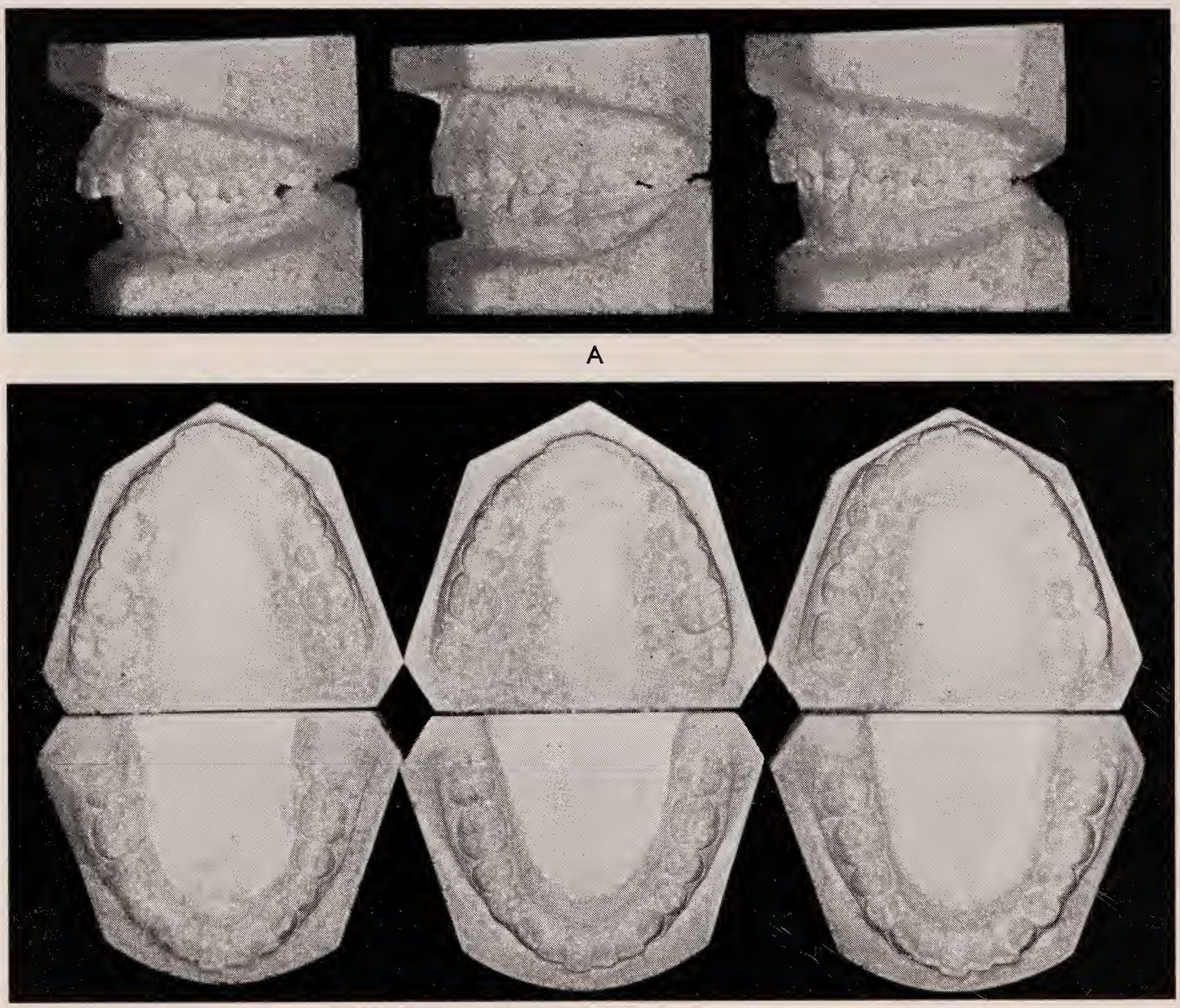


C

Fig. 8.—Records of ' Valerie '. A and B, Models taken before insertion of Andresen appliance, at end of retention, and 3 years 9 months out of retention. C, Lateral radiographs taken before treatment, at end of retention, and 3 years 9 months out of retention.

upper removable appliance was worn until March, 1961, and thereafter as a nocturnal retainer until September, 1961. The patient wore the Andresen appliances for 2 years 4 months, followed by the upper removable appliance for 4 months, and this was then worn nocturnally as a retainer for 6 months. The final records were taken 2 years 4 months out of retention.

The changes during and after treatment are shown in *Fig*. 7. Again, these are essentially changes of tooth position, although the angle ANB decreased by 2·5°, which was helpful. Such a change during adolescence is not unusual, and in a recent survey of 35 children of a similar age-range, in whom treatment had been confined to the upper jaw (Mills, 1964), a reduction in the angle ANB of at least 2·5° was seen in 7 cases,



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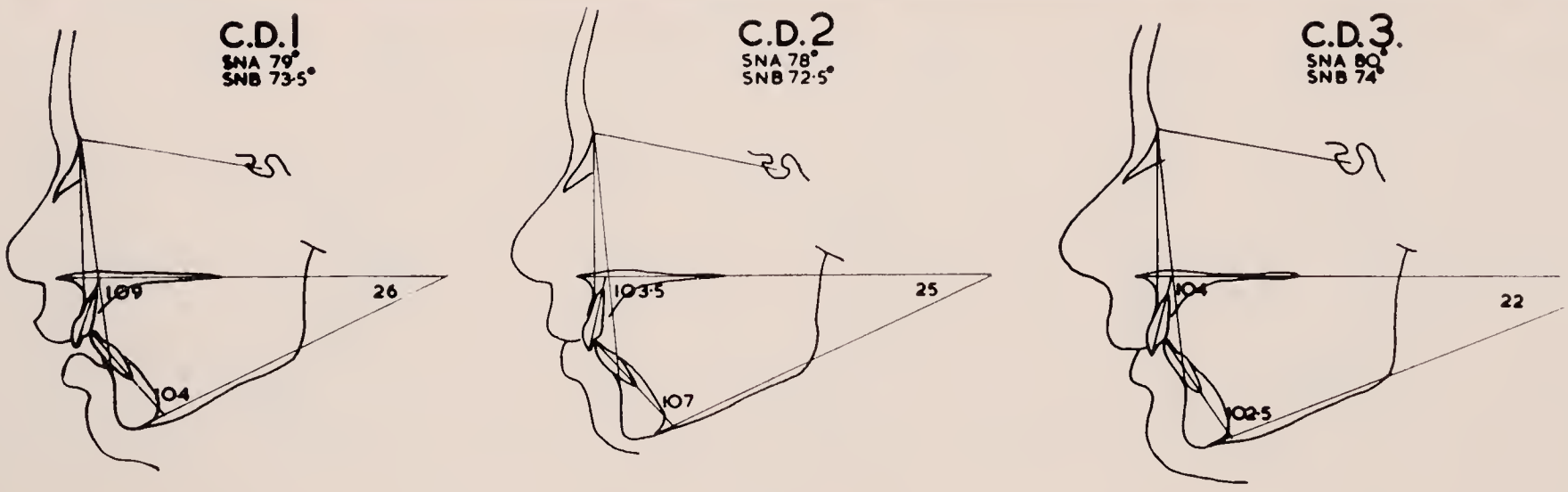

C

Fig. 9.—Records of ' Cynthia ', taken before treatment, at end of retention, and 4 years 4 months out of retention. A, Left lateral view of models. B, Occlusal view of models. C, Tracings of radiographs.

while in an untreated control group of 23 children such a reduction took place in 4 cases.

Valerie (*Fig.* 8) was first seen in December 1957, at the age of 12 years. She had an essentially Class I skeletal pattern, with potentially competent lips, with the lower lip trapping under the upper incisors. These were markedly proclined and slightly spaced, with an increased overjet. The maxillo-mandibular planes angle was high, and because of this, the overbite was not quite complete. The posterior occlusion was Class II.

An upper removable appliance was first fitted to close the upper anterior spacing and reduce the overbite, this being worn from February to July, 1958. A first Andresen appliance was then constructed and this was worn nocturnally with the conventional appliance diurnally until we were sure that the Andresen appliance was being tolerated; in this case for 1 month only. The upper removable appliance then discontinued. A second Andresen appliance was fitted in June, 1959, and wear was reduced to three nights per week from March to May, 1960. The patient, therefore, wore the upper removable appliance for 5 months, the Andresen appliance for 20 months, followed by 2 months retention. The final records were taken 3 years 9 months out of retention.

This patient showed the greatest reduction of overjet of the group. The most noteworthy changes was the proclination of 10° of the lower incisors, which did not change after treatment.

Cynthia (*Fig.* 9) was less successful. She was first seen in June, 1958, at the age of 10 years 7 months, with one of those mild malocclusions which can be difficult to improve. She had a marked Class II skeletal pattern, with an ANB angle of 5·5°. The molars and canines were in Class II relation. The lower incisors had a natural proclination, being 10° above the average figure, and this partially compensated for the skeletal discrepancy. The upper incisor angle of 109° to the maxillary plane coincided with Ballard's average for London schoolchildren. Thus there had been a natural compensation for the skeletal discrepancy, leaving the patient with a slight increase in overjet and a mild crowding of the upper labial segment.

The parent was very anxious that the child should receive treatment and I therefore decided, probably wrongly, to use an Andresen appliance. Only one such appliance was required, and was worn from June, 1958, to July, 1959, followed by retention three nights per week until October, 1959. The final records were taken 4 years 4 months out of retention. There was a slight relapse of three of the incisors, while $\underline{|2}$ remained in close contact with the lower incisors. This result was not perfect, and in such a mild malocclusion any improvement short of perfection is hardly worth the effort.

This has been a personal account of my own use of the Andresen appliance, and inevitably others will disagree with some of my findings. I believe that much of the disrepute into which this appliance has fallen is due to a tendency to ' try an Andresen ' when all else has failed or is likely to fail. I do not believe in miracles. On the other hand, used in the type of case which I have illustrated, with the operator's confidence transferred to the patient, it will produce results which I cannot achieve with any other appliance.

Acknowledgements

I wish to thank the Photographic Department, Eastman Dental Hospital, for preparation of photographs, Miss J. Jeffrey for secretarial assistance, and numerous postgraduate students and registrars of the Eastman Dental Hospital who co-operated with me in treating the patients.

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IV. PANEL DISCUSSION

Dr. W. J. TULLEY (Chairman), Mr. G. C. DICKSON, Dr. W. GROSSMANN, Dr. J. R. E. MILLS, and Professor R. E. MOYERS

Dr. W. J. Tulley: **What effect does the activator have on the skeletal pattern?**

Dr. W. Grossmann: In my experience, it has very little effect after the age of 12 years. The first case which I showed indicated what happens in the early mixed dentition. I do not believe that bone can be made to grow beyond its inherited potential. I do, however, believe that in some cases, particularly Class II, division 1, due to environmental factors, the mandible has not had a chance to develop up to its inherited maximum growth potential. If it is freed, it will grow up to this maximum, but nothing will make it grow if the growth potential is not there. I think this can happen with other forms of traction as well as the activator. I also think that in certain cases the forward growth of the maxilla could, with intermaxillary traction, be restrained.

Tulley: That seems to be a qualified no.

Mr. G. C. Dickson: I have not seen in any of my cases any change in the skeletal pattern which could not have taken place either with natural growth or been brought about by another appliance. In other words, I do not think I have a single case where a change in the skeletal pattern could be attributed to the activator.

Dr. J. R. E. Mills: This is a controversial point and, as with so many controversial points, firstly we do not really know and, secondly, it does not really matter. I think there have been four cephalometric investigations into the results of treatment with the Andresen appliance. In two, by Professor Bjork, and Mr. Softley on very small groups, no change was shown. In the other two, by Dr. Gresham and Mr. Moss, the investigators claimed to show a change in skeletal pattern slightly greater than one would expect in normal growth. In both cases this was confined to a small proportion of the patients.

Even if we accept the findings of these two investigations, the changes claimed are very minor in extent, rather unpredictable, and, therefore, of no clinical significance. I should add that I personally think their findings are capable of other explanations, and I can see no theoretical reason why the Andresen appliance should change the skeletal pattern.

Professor R. E. Moyers: Some work has recently been carried out in my department by Harris on this problem. His findings corroborate those mentioned by Mills. Immediately after use of the Andresen appliance, there would seem to be a favourable change in the skeletal pattern in an unpredictable small proportion of the cases. However, this was followed by a lag in growth so that at maturity the individuals concerned seemed to have the skeletal pattern which they would have achieved had they never worn an appliance.

Whatever the pattern I do not think we altered it. We might jig it around a little more advantageously, we might alter the timing, but that was all.

Tulley: **In the panel's opinion, at what age should treatment be commenced with this kind of appliance?**

Grossmann: That depends on who is carrying out the treatment. An inexperienced person should not attempt to treat any child under the age of 12 years, but for the more experienced operator I think the best time is the mixed dentition, and in Class II, division 2 cases, the early mixed dentition. In Class II, division 2 cases, I believe that the chance of success is small if the child is more than 9 to 10 years old. In Class II, division 1 it does not matter so much, but again 9 or 10 years is the best time.

Dickson: I would not have known this until I did my survey. Before this survey, I thought the best time was the mixed dentition, but the survey showed beyond doubt that, in my hands, the percentage of successful cases rose enormously towards the older end of the scale. In future, I shall treat only at the completion of the antemolar permanent dentition.

Moyers: The only point is the timing of growth. We treat girls exactly one year earlier than we treat boys, and Harris's paper on mandibular growth supports this. We have usually treated cases in the very early mixed dentition.

Mills: I find that I get much better results if I treat the patients in the complete permanent dentitions, as Dickson has suggested. This makes treatment very much shorter and consequently one keeps the patient's co-operation very much more successfully. It is, of course, perfectly possible to treat in the mixed dentition, but in that case the treatment tends to drag on for four or five years.

I am, on the other hand, very much opposed to the idea of trying out an Andresen in the mixed dentition in the vague hope that it might work with the intention of using some other appliance later if it doesn't. In that case, the patient gets tired of treatment before it really starts!

Tulley: I would cast my vote with Dickson and Mills.

Tulley: **Can the activator be considered as a complete bite platform serving as an anchorage reinforcement when various additional mechanisms are incorporated?**

Mills: I have not a lot of experience in adding auxiliary springs to Andresen appliances. I think this results in one designing an appliance which would work well if the patient only wore it, but unfortunately is so complicated that the patient doesn't wear it.

I think any appliance should be the simplest appliance which will carry out the treatment required. If the treatment is complicated, then probably a simple form of a complicated banded appliance is very much better than a complicated form of a basically simple appliance.

Moyers: I agree. I think people would get better results with Andresens if they used them only in those cases in which they are known to be successful.

Grossmann: It is entirely wrong to include any springs in Andresen appliances. The original simple form is the most effective.

Dickson: I agree.

Tulley: **Would the panel give their opinion on the use of the Andresen appliance in conjunction with extra-oral traction?**

Grossmann: I have no great experience of this, but I have no doubt it is very useful in some cases.

Dickson: At least if extra-oral traction is used, the plate can't fall out! In the few cases in which I have used it, it has been successful, but the number is too small to be of any significance.

Mills: I think this is an example of complicating the appliance. If I want to use extra-oral traction, I use it with more conventional appliances.

Moyers: I don't believe it is an Andresen appliance if extra-oral traction is added. An Andresen appliance must be loose in the mouth.

Tulley: Harvey Jenkins has used a form of skull cap which he has fitted to the Andresen to hold the appliance in the mouth.

Moyers: That isn't an Andresen. It was used for an entirely different purpose!

Tulley: **What advantages has the use of an activator in the treatment of Class II, division 2 cases in the early mixed dentition over the more conventional approach at a later stage of development?**

Dickson: I have very limited experience of the Andresen in Class II, division 2. What experience I have was shared with Mr. Hooper who tried this at one time. Mr. Hooper found that he had a very high relapse rate, although the initial treatments were successful.

Grossmann: Everyone would agree that Class II, division 2 have a high relapse rate, no matter what appliance is used. I think the important thing in Class II, division 2 is to change the muscle environment which influences the position of the labial segment and I feel that this can only be accomplished in the young patient. In Class II, division 2 the premaxillary bone is quite different from that in Class II, division 1. In Class II, division 1 there are large bone-marrow spaces which are easily influenced by any functional stimulation. In Class II, division 2, the bone is very dense and the teeth can only be moved easily at a young age.

Moyers: I find that the English concept of Class II, division 2 is so different from the American concept that we are not even talking about the same thing. Swann, in 1952, investigated Class II, division 2 and he found that the skeletal pattern was more like Class I than Class II, division 1. The abnormality seems to be in the dental pattern rather than the skeletal pattern, and our treatment is to start at an early age and is confined to tooth moving. We never touch the maxillary central incisors. If they are pushed labially, they are not stable.

Mills: I have never had a very high success rate with the Andresen appliance in Class II, division 2, and I have stopped using it. I don't really know why, but I think there are two reasons. I said in my paper that the Andresen appliance works best where there are long dental bases. In Class II, division 2 the dental bases, although broad, are usually short antero-posteriorly. In the odd case, where the dental base is long, the Andresen might be indicated.

The second reason concerns the vertical dimension. In Class II, division 2 the lower facial height is usually small and, again, I do not think the Andresen is indicated here. Again, in the exceptional case with a normal facial height, it might work well. I would suggest that one should start one's experience of the Andresen with some other kind of case!

Tulley: It would seem that the panel is not very keen on the Andresen appliance in Class II, division 2, but if it is used it should be used in the mixed dentition.

Tulley: **How many hours per day should the appliance be worn, i.e., only in bed or for several hours also in the evening?**

Mills: Only in bed.

Moyers: My patients are told to pop the appliance in their mouth when they begin their homework after dinner. This helps the patients to learn to wear the appliance.

Grossmann: I ask my patients to wear the appliance one hour a day in the beginning until the plate stays in all through the night. Once the plate is staying in, they wear it only whilst in bed.

Dickson: I think any removable appliance has to be sold to the patient, the Andresen more so than most. I tell my patients to wear it for an hour before bed and in bed afterwards until it stays in long enough to be sure that it will go on staying in. I tell them that for the first three nights it will fall out and the patient will find it in the bed in the morning. On the fourth morning, the patient will wake up with the appliance in position in the mouth. This seems to work successfully.

Tulley: **Do patients really consider this a bulky appliance?**

Dickson: With most appliances patients can speak and eat, with the Andresen they can do neither. At least, not at first! The patient has to make quite an effort in the first few days, but, after this, it is almost a hardship to be without the appliance.

Grossmann: Most of my patients do not complain that it is a bulky appliance. One or two do but they would complain with any other appliance.

Mills: It depends on whether it is a bulky appliance! I believe strongly that the appliance should not displace the mandible more than is comfortable. The mandible must neither be protruded too far nor opened too far. If these rules are borne in mind, the appliance is not unduly bulky and patients don't complain about it.

Grossmann: The only appliance about which my patients complain is the oral screen. To keep that in the mouth involves a far greater strain.

Moyers: I think most of the worry about bulk is an attitude in the orthodontist's mind. If the orthodontist is too pleading, the children's natural defensive reflexes begin to operate and good results aren't obtained. If it is merely handed to the children on the assumption that

it will work all right, it does. Provided the appliance is not unduly bulky and is neat and tidy, it should be worn well by the end of a week.

Mills: One cause of apparent bulk is the appliance being too deep in the area behind the lower incisors. If it is extended under the tongue, it appears bulky to the child and it would not be worn.

Moyers: The appliance is more likely to seem bulky if the bite isn't open far enough. The tongue has a certain volume, and if the vertical dimension is increased this makes more room for the tongue and the child objects less to the appliance.

Tulley: **Does electromyographic evidence indicate that one should open the bite beyond the rest position in constructing the Andresen appliance?**

Grossmann: I do not use the electromyograph to judge the amount of bite opening which is required. All I use it for is to indicate how the muscles are responding in a case of displacement.

Tulley: I wasn't implying that one should use the electromyograph in every case to get the correct bite, but does it indicate anything critical in the rest position?

Moyers: There may be, but I have never taken it that far to find out. Ahlgren working in my laboratory has studied the initial response of the extrinsic musculature to the insertion of activators. He has not found that the appliance activated or stimulated the muscles as Andresen said.

Tulley: One of our undergraduates at Guy's Hospital has undertaken a piece of research which shows that if the bite is opened beyond the rest position, no additional effect is produced on the musculature. The rest position didn't seem to have any special significance.

Tulley: **Would the speakers comment on the use of the Andresen system in Class III malocclusion?**

Grossmann: I use the system in suitable Class III cases; that is in very mild postural cases. I no longer use the screw placed anteroposteriorly between the two segments of the plate.

Dickson: I no longer use it in Class III cases. In my hands, it has been successful in moving the lower labial segment posteriorly, but I haven't found it successful in moving the molars distally.

Moyers: I don't use it in Class III cases.

Mills: I have used it in Class III cases although I think I now know easier ways of treating these cases. Where it is used, it seems to work very much better with children in the early mixed dentition, unlike Class II, division 1 cases.

Tulley: **Dr. Mills, in his paper, has indicated how he trims the appliance. Would the other members of the team indicate their technique?**

Grossmann: I trim in the same way as Mills.

Dickson: I trim rather differently. Spurs on the plate should fit the teeth rather as the cogs on one cogwheel fit the opposing cogs on another wheel. You don't need to trim away the opposing cog to allow movement, and, in the same way, I prefer to leave a long spur between the teeth with no trimming away. As the teeth move, the plate moves with them.

Moyers: We trim our activators to allow distal eruption of the upper teeth. As they develop vertically we guide the upper teeth backwards. We try to avoid the lower teeth coming forward so that, in fact, we need twice as much correction in the upper arch. In the United States, we are very worried about getting the lower incisors off the base.

Mills: I like to trim away as much acrylic as possible. There are two basic reasons for this. Firstly, if the teeth are going to move, they will do this by tilting and they have a much better chance of tilting if there is as little acrylic round them as possible. Secondly, the object is to move the upper cheek teeth distally. Now 'distally' is backwards and outwards. If the appliance is constructed to move them only backwards and not outwards, they will not, in fact, move. By trimming the plate thoroughly, they are allowed to take the line of least resistance. For this reason, I like to trim away a lot of acrylic in the upper arch. I don't worry very much about the lower arch—I agree it is better if the lower arch isn't brought forward more than can be helped.

In the case of a complete overbite, I trim away all the acrylic between the posterior teeth. Where the overbite is incomplete at the beginning of treatment, I leave a shelf of acrylic in contact with the tips of the cusps of the posterior teeth to prevent further reduction of overbite. I usually avoid trimming behind the upper anteriors for as long as possible. If one trims freely round the posterior teeth and also behind the upper anterior teeth, the plate is only really touching the lower anterior teeth, and these can become very loose.

Grossmann: So far we have only talked about trimming in the anteroposterior plane, but in the mixed dentition as the premolars are just erupting, it is most important that the plate should remain in contact with their lingual surfaces otherwise they are liable to tilt inwards.

I don't agree with Mills about filing behind the upper anterior teeth. He has shown a case where he closed up the upper anterior spacing before using the Andresen appliance. I like to keep this spacing and to close it with the Andresen appliance. It is important not to trim away too much of the acrylic or the lower lip will get in between the upper incisor and the plate. I trim away a little each time the patient comes.

Dickson: If you do trim behind the upper incisors, it is essential not to over-activate the labial arch. This should be activated only very

slightly otherwise it is liable to cause soreness in the palate behind the upper incisors.

Mills: The object of trimming away behind the upper incisors is to move these teeth lingually relative to the upper posterior teeth. That is to close spacing of incisors. If you want to move the whole upper arch posteriorly, then little or no trimming is necessary. Where the upper anteriors were spaced, I prefer to close them with the appliance I mentioned first, but I quite agree with Dickson that it can be done with an Andresen, provided it is activated very slightly at each visit.

Tulley: I believe that if you don't trim behind the upper incisors, a lot of time is wasted.

Tulley: **Would Dr. Grossmann amplify his statement ' different growth patterns in Class II, division 2 and Class II, division 1 malocclusion '?**

Grossmann: There is a very marked downward growth of the mandible in Class II, division 2.

Moyers: That, of course, is well documented in the literature.

A Member: In certain Class II, division 1 and Class II, division 2 cases, the patient has an abnormal rest position with the mandible in a forward posture. Would this be a contra-indication to using an Andresen appliance? The appliance is activated by bringing the mandible forward. Here the patient is already holding his mandible in a forward position.

Tulley: Dr. Grossmann, in his paper, said that he found a forward posture to be a good sign.

Grossmann: No, that wasn't quite what I meant. What I said was that if the mandible, in closing from the rest position, comes upwards and backwards, then this is an unfavourable sign. This is in cases with a normal rest position. Where the rest position is abnormal, I would expect a poorer result.

Mills: It is widely taught that where the mandible is in an abnormal forward rest position, the Andresen does not work. This would seem right on theoretical grounds and is mentioned by Hovell in an article in the *Angle Orthodontist.* In my experience, it is not true and these cases work just as well.

Tulley: **Is the activator a suitable appliance for use following the extraction of all the first permanent molars in a Class II, division 1 malocclusion?**

Mills: I remember Mr. Rix showing me a case of a Class II, division 1 malocclusion with no teeth posterior to the first premolars. He had treated that very successfully with an Andresen appliance and I have used it on one occasion similarly. I would much prefer not to extract the first molars until the second molars had erupted and one can control them with conventional appliances. I would regard the use of the Andresen appliance as a desperate treatment of a desperate situation.

Grossmann: I agree. This is not an ideal way to use the Andresen, but if one is faced with a situation where the first molars have already been lost, then you try it because there is nothing else. Some go well and some do not.

Dickson: I think the Andresen is as satisfactory as any other appliance. Alternatively, you can use extra-oral traction on an upper appliance.

Tulley: I have seen a number of Mr. Rix's cases that have gone well in this way although, of course, it is a measure of desperation in anyone's hands. I think these cases would have gone well with a full dentition.

Tulley: **Mr. Dickson has 96 per cent success with cases with incompetent lips as compared with 60 per cent with competent lips. Could he tell us whether the cases with incompetent lips became competent following treatment? Similarly was any improvement in swallowing noticed?**

Dickson: There is some variation in the definition of incompetent lips. I mean that the lips will not meet when the teeth have been retracted, except of course by over-activity of the lower lip. I don't think, therefore, that they can change, but I imagine there is some adaptive change in the swallowing pattern, in at least some cases.

Tulley: **Should the Norwegian plate have a Coffin spring or other expansion device incorporated into it, to ensure expansion of the upper cheek teeth during their distal movement?**

Moyers: I never incorporate Coffin springs or screws.

Grossmann: I use screws, never Coffin springs because they get distorted.

Dickson: I use Coffin springs in all cases.

Tulley: **Does the panel think that one of the reasons for the success of the appliance in Europe compared with its success in England is due to the larger and broader arches which are found on the Continent?**

Grossmann: I have lived on the Continent for a long time. I don't know if there are broader arches over there, but I would not have thought that there was much difference between the upper jaw of a child in Prague and that of a child in London. There are certainly failures on the Continent, and these are usually due to a lack of experience of the operator. It is of course nonsense to suggest that the children in one country are more co-operative than those in another. I think these are excuses for failure of the appliance.

Dickson: The appliance originated in Norway and had an attraction there because the population is so scattered and it involves less frequent visits.

Mills: This reminds me of the famous headline in *The Times*, ' Storms in the Channel—Continent Isolated '. The appliance had its origin successively in France, Norway, and Vienna; countries with quite different populations. I gather that Dr. Andresen himself was, to say the least of it, not one hundred per cent successful.

Tulley: **Would Dr. Grossmann discuss the extraction of second permanent molars with the Andresen appliance, possibly to prevent late deterioration in the lower incisor segment?**

Grossmann: I am very keen on extracting second molars, particularly if crowding is developing, but I think it is important that this should be done reasonably early, before the age of thirteen. I often do it in Class II, division 2 cases.

A Member: Would the panel discuss the effect on the lower incisors of the proclination which would result from the use of an Andresen appliance?

Mills: This is, again, a theory which is not born out in practice. One would expect that the intermaxillary traction produced by the Andresen appliance would procline the lower incisors and that, following treatment, they would drop back and become crowded. In my experience, this isn't so. Most of the cases I showed were proclined perhaps five degrees. This is only about 1·25 mm. or less. In the cases which I have studied, incisors were not unduly proclined and they did not later become crowded.

Moyers: I am always frightened of tipping lower incisors forward and I grind the activator at the lingual side of the crowns. One selects one's cases and this needn't happen if the activator is correctly ground.

Grossmann: I agree with Mills. I have not seen excessive proclination of the lower incisors. If it is observed, it is usually because the appliance has not been correctly constructed.

Tulley: Well, I am sure you would wish me to thank the members of the panel who have taken part today, and especially Professor Moyers, who has come all the way from Greece to present his paper and to take part.

TEACHING AIDS FOR UNDERGRADUATES

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J. D. McEWEN, L.D.S., D.D.O.

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THE majority of dental students will enter general practice and require a knowledge of orthodontic diagnosis; they will also be expected to treat simple malocclusions. In undergraduate teaching, it is sometimes difficult to ensure that each and every student observes or treats the correct type and number of patients. Equally, the busy teacher may not in the presence of the patient be

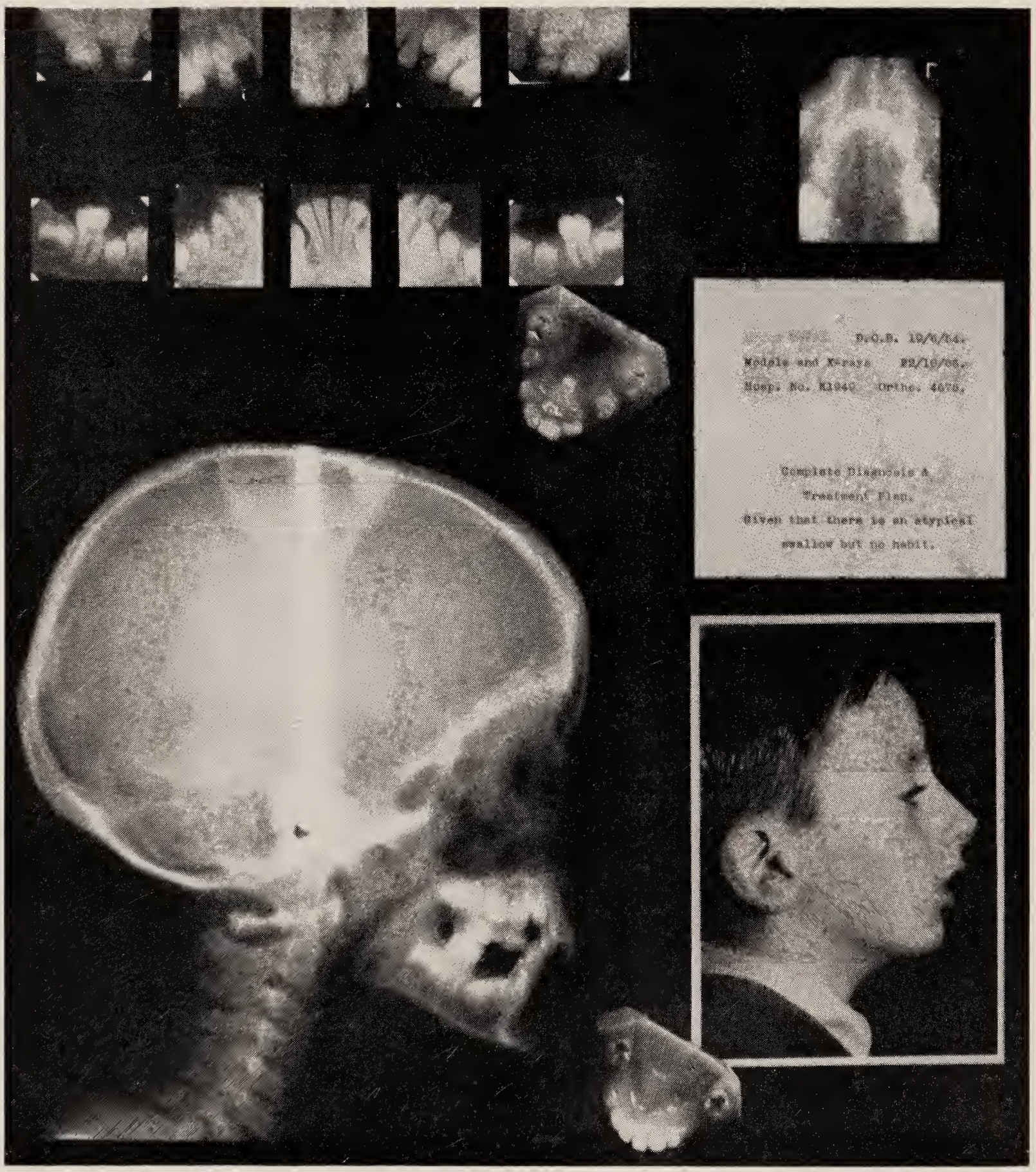


Fig. 1.—A diagnosis sheet with X-rays, photographs, and models.

A demonstration presented at the Country Meeting held in Plymouth on 22 May, 1964.

able to give his full attention to the explanation of the case. We have found it useful to have a stock of teaching models which can illustrate points in diagnosis and simulate aspects of clinical teaching. These can ensure that every student has covered certain facets of the subject and reduces the number of stray sheep per year. Some of these aids are illustrated in the following sections.

Fig. 2.—The plastic 'skull' illustrating skeletal Class I pattern.

Fig. 3.—Illustrating a Class II skeletal pattern and Class II, division 1 incisor relationship.

DIAGNOSIS

A lateral skull and full mouth X-rays, a profile photograph and notes on such features that may not be apparent, e.g., habits, hereditary tendencies, soft-tissue behaviour patterns, and so on, have been mounted between perspex sheets (*Fig.* 1). The study models of the patient have also been reproduced in acrylic, with accurate representation of any caries or conservation treatment.

The plastic sheet and models can be given to the student, who then has the information necessary to complete a diagnosis and treatment plan on prepared forms just as he would do if the patient was present in the clinic. The teacher may leave the discussion until several students have had time to look at the material and prepare forms.

CEPHALOMETRICS

The student can now progress to the study of the lateral skull radiograph. The plastic sheets fit exactly into a viewing-box and the tracing-paper can be clipped over the film. The skeletal pattern and other relevant measurements and angles can now be traced and measured.

To aid cephalometric teaching, a plastic skull is also used. This is by no means a new idea. Hallet (1954) demonstrated how different types of malocclusion could be set up with plastic teeth held by petroleum jelly on sliding glass plates. Pogrel (1957) modified this by using suction-pads and magnets instead of petroleum jelly.

Fig. 4.—A Class III skeletal pattern with 'normal' Frankfurt-mandibular-plane angle.

Scott (1959) and Nicol (1960) showed models derived from lateral skull X-rays. The

Fig. 5.—Overcrowding treatment by serial extractions showing in the middle the acrylic master models for the lecturer, and above and below the rubber moulds and duplicated stone models for the students.

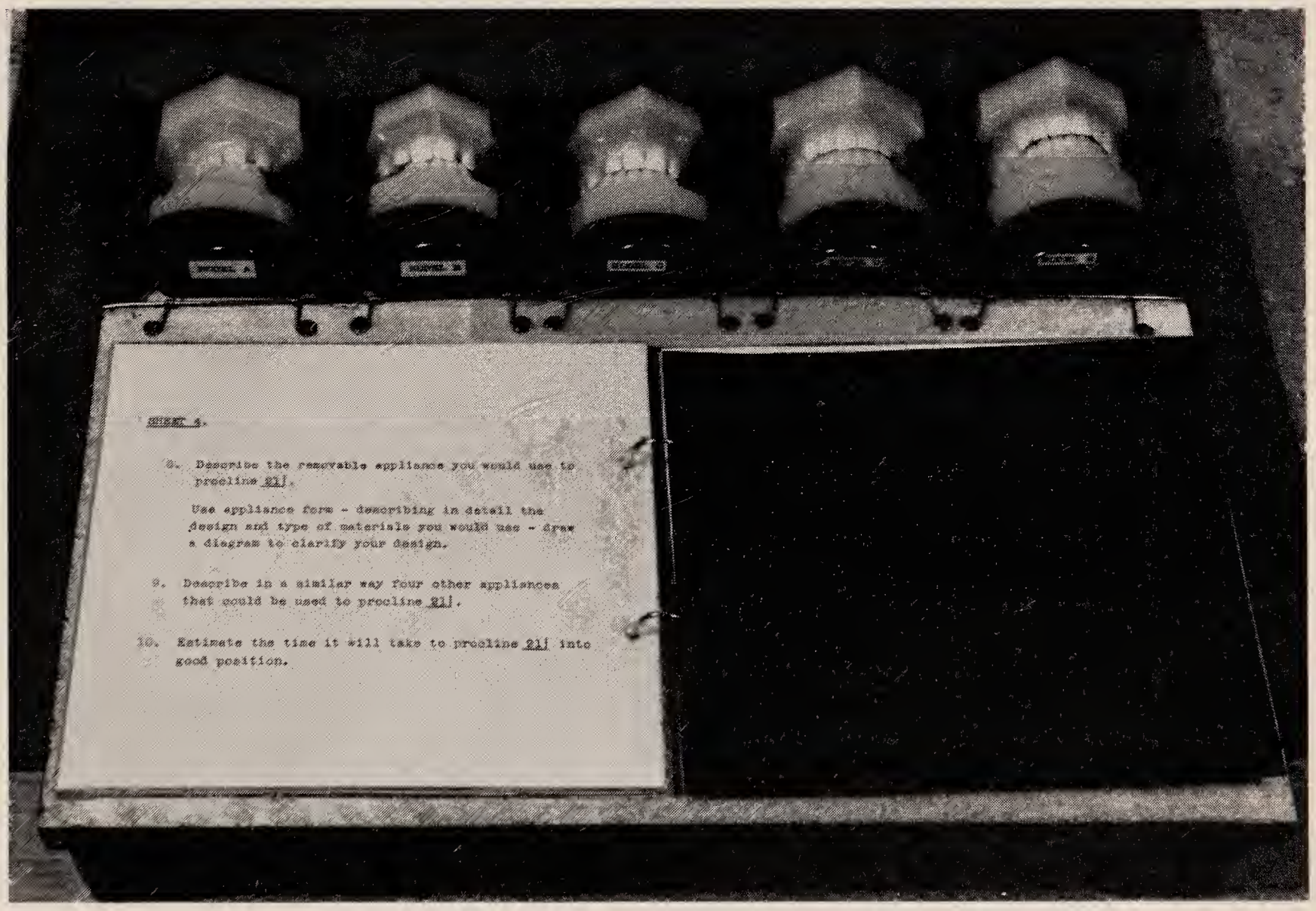

Case 3.
8. Describe the removable appliance you would use to procline 21.
Use appliance form - describing in detail the design and type of materials you would use - draw a diagram to clarify your design.
9. Describe in a similar way four other appliances that could be used to procline 21.
10. Estimate the time it will take to procline 21 into good position.

Fig. 6.—Showing board with patient's models clipped in place and some of the question sheets.

angulation of the incisors to the Frankfurt and the mandibular planes could be altered and was indicated on a scale, and the mandible could also be extended to simulate different skeletal patterns.

The present model (*Fig*. 2) has taken the system a stage further and has been designed to show undergraduates how to interpret and evaluate lateral skull X-ray tracings rather than to set up specific malocclusions, although these can be produced. The plan of the skull was made by photographic enlargements of a lateral skull X-ray tracing, the angles of which were as near the mean as it was possible to find, i.e.,

SNA angle	80°
SNB angle	78°
$\frac{1\|1}{}$ to maxillary plane	110°
$\frac{}{1\|1}$ to mandibular plane	90°
Frankfurt-mandibular-plane angle	28°

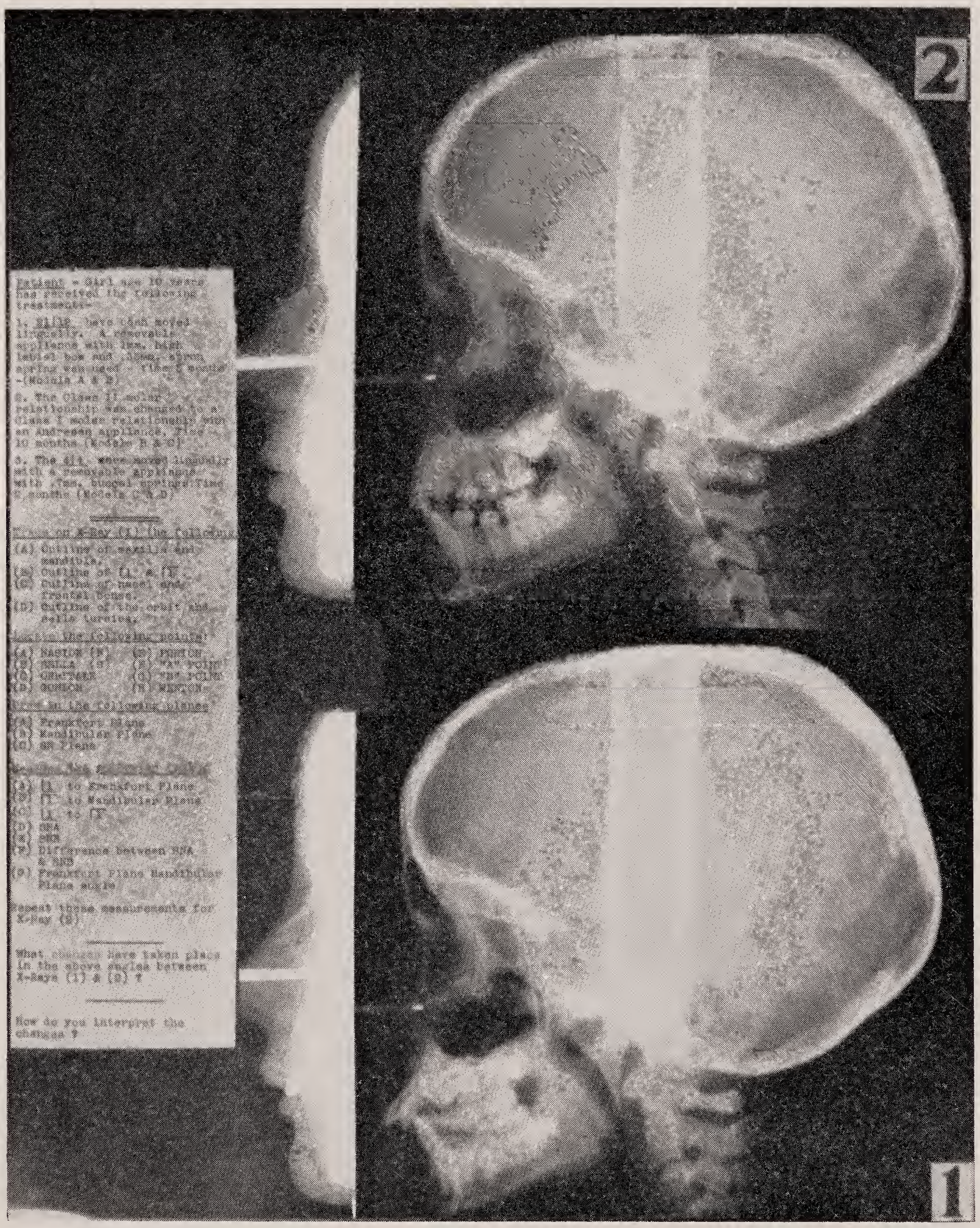


Fig. 7.—Lateral skull X-rays before and after treatment.

The model was cut from $\frac{1}{8}$-in. acrylic sheet and mounted on a plywood base. Moving parts were held on the base by screws with rubber friction grips intervening.

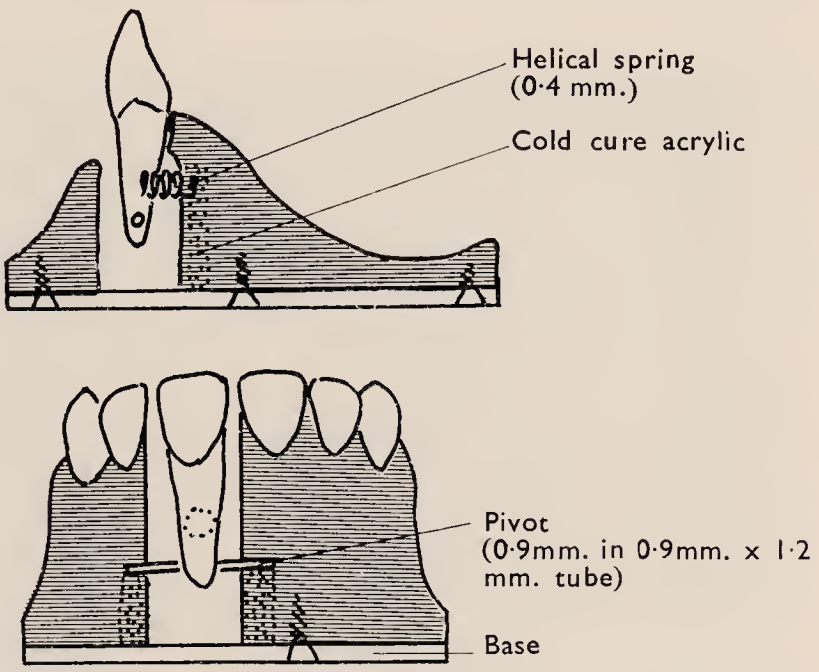
Maxillary and mandibular bases were made to slide anteroposteriorly. Sella, nasion, A, and B points were indicated, and degree scales engraved on the skull. The gonial angle was also made adjustable so that any skeletal pattern could be set up accurately (*Figs.* 3 and 4). The upper and lower incisors were pivoted near the apical third and scales engraved to show directly the angles they made with the maxillary and the mandibular planes.

A metal plate inserted into the base board in the 'mouth' would allow magnetized first permanent molar models to be positioned to illustrate Angle's classification as necessary. The model can be used to visually present the measurements from the student's tracing. It is a useful adjunct to seminar teaching, and can be used to discuss the effects of treatment.

TREATMENT

Students are not usually able to follow the orthodontic treatment of children over a long period. To enable groups of students to study the models of treated cases, duplicate models from rubber moulds (Piper, 1949) have been found useful. A set of master acrylic models is produced, and a sufficient number of plaster models are made from rubber moulds to allow each student to have a set of his own. Then, as the demonstrator discusses the case, the student should have no difficulty in noting all the features (*Fig.* 5).

In order to give practice in the management of the orthodontic case a further teaching model was produced. Here the salient points from the case history of each patient were reproduced on cards with questions about the malocclusion, the aetiology, and possible methods of treatment, and these were bound in the plastic sheets and fixed to a base which also had clips to hold the models. Students working either singly or in pairs can take a board and work their way through a programmed-teaching sheet. A good programme will take a student about one and a quarter hours to complete (*Fig.* 6). To further illustrate the results of treatment acrylic models and lateral skull radiographs before and after treatment have been produced. The student can trace the radiograph and assess how the correction of the malocclusion was achieved. Plastic sheets as previously described having the hard and soft tissue radiographs and the required analysis have been found useful (*Fig.* 7).



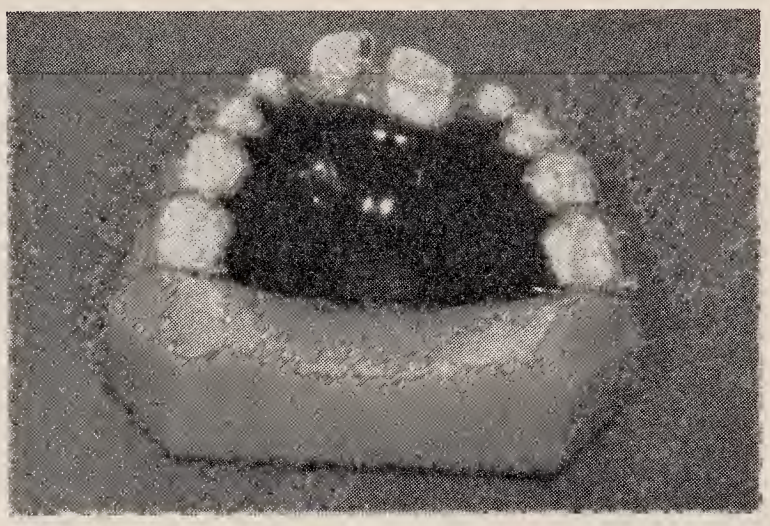


Fig. 8.—Diagram of master model with moving tooth for appliance construction and photograph of completed model.

APPLIANCE CONSTRUCTION

Wire bending on plaster models can become tedious if not related to the clinical problem. To enable the student to visualize the movement required master models of different malocclusions have been prepared. These have the tooth to be moved pivoted near its apex and held in the malposition by a spring somewhat in the manner described by Rose (1954). A rubber mould is also available for duplicates of each master model (*Fig.* 8).

The students construct and process their own plates on the duplicate models, and when the plates have been trimmed and polished the student can see for himself how to adjust the finger springs so that they exert the correct pressure (decided by a spring gauge) to move the malpositioned tooth in the right direction.

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A CASE OF CLASS II, DIVISION 1 MALOCCLUSION

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INTRODUCTION

This case was thought to be of some interest because of the aetiological factors involved and also because it serves to illustrate the narrow dividing line between those difficult cases where treatment might effect some improvement and those which are virtually untreatable. The aetiological factors which are of importance in this case, and which have been discussed at length in the literature, concern tongue activity.

Fig. 1.—Photographs of the patient before treatment, showing her *above* with lips at rest and *below* with the lips held together.

CASE REPORT

The patient, a 12-year-old girl, was described as having a Class II, division 1 malocclusion with a high maxillary-mandibular planes angle and a considerable degree of postnormality of mandibular dental base. The lips were incompetent and an anterior oral seal was achieved by lip-to-tongue contact. The upper incisors were normally inclined to the maxillary plane, but the lower incisors were very much proclined to the mandibular plane. An anterior open bite extending from upper left to upper right canine was present. The lip-to-tongue activity was responsible for the proclination of the lower incisors and was in part responsible for the anterior open bite. The high maxillary-mandibular planes angle also contributed to the open bite. Also present was an interdental sigmatism. There was no history of thumb-sucking, and the overjet was markedly increased. The malocclusion was due to superimposition of soft-tissue factors, mainly lip tongue contact and incompetent lips, on a severe Class II skeletal pattern.

Fig. 1 shows the patient at the commencement of treatment when she was aged 12. The degree of lip incompetence is shown quite clearly and also the degree of muscular effort required to approximate the lips.

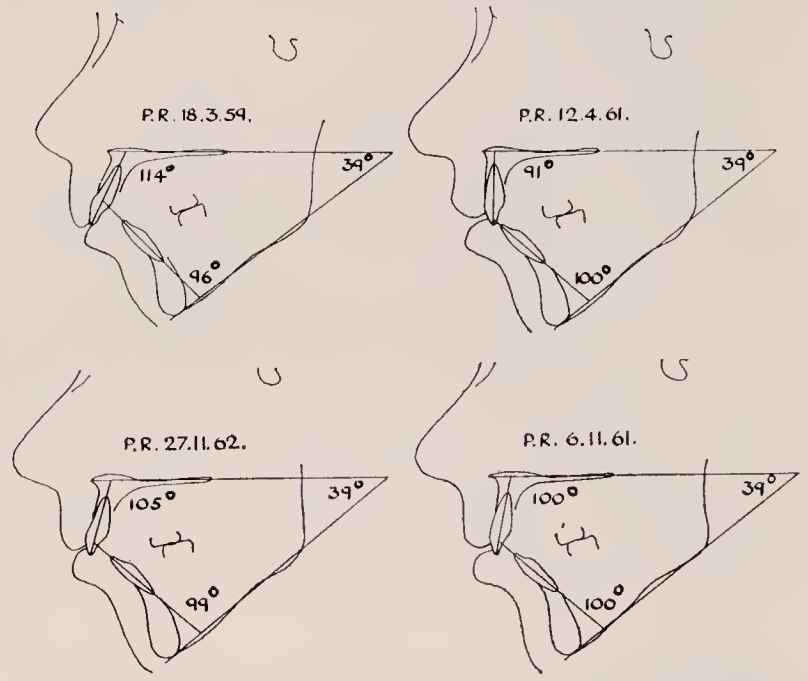

Fig. 2.—Tracings of lateral skull radiographs, *upper left* before treatment, *upper right* at the end of treatment, *lower left* and *right* after treatment.

TREATMENT

Treatment consisted of the loss of upper first premolars and retraction of the upper labial segment. A removable appliance was used to retract $\underline{3|3}$ and fixed appliance to retract the incisors. Overjet was reduced mainly by tipping upper incisors lingually.

Fig. 2 shows the tracings of the lateral skull radiographs at appropriate stages during treatment. The upper left at the start of treatment. The upper incisors at an angle of 114° to the maxillary plane.

Presented at the Country Meeting held in Plymouth on 23 May, 1964.

Treatment over the next eighteen months reduced this angle by some 23°. The lower incisors were proclined slightly, but this was not through any active treatment. The upper right tracing shows the degree to which the overjet was reduced.

The models (*Fig.* 3) show clearly the extent to which the overjet was reduced; the upper left being at the start of treatment, the upper right at the end of active treatment, while the lower left model shows the magnitude of the relapse. *Fig.* 4 shows the patient following treatment.

During the course of treatment the overjet was reduced almost completely, the upper incisors being retroclined some 23° in the process. The appliances

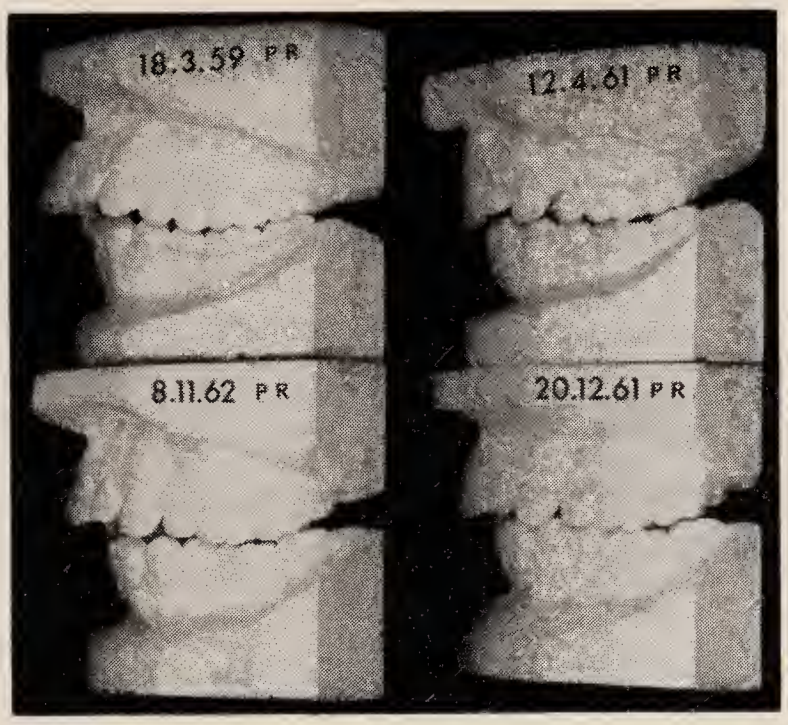

Fig. 3.—Left lateral view of models taken before treatment, at the end of treatment, and during relapse.

were then removed and the incisors relapsed to a stable position, where the overjet was reduced by about one-third of the original overjet. No retention was used.

DISCUSSION

Tongue behaviour has frequently been discussed in literature, namely by Froeschels (1937), Rix (1946), and Ballard (1956, 1960).

From the point of view of achieving a stable end-result, I think the important factor here is the tongue thrust. When the case was originally diagnosed, it was considered that this was the adaptive or habit type of thrust as described by Ballard (1960). The other aetiological factors present make it difficult to say that it was not a habit thrust where the tongue conformed to the other morphological features and was used to produce an anterior oral seal. Here we have a case with a large number of aetiological factors present and the tongue might be a primary factor, in other words a true endogenous thrust; or it might play a secondary role where it had to adapt to the existing morphological environment. A close watch was kept on the tongue activity during treatment. It had been anticipated originally that, if adaptive, the tongue activity would be modified as treatment proceeded and the overjet was reduced. The anterior oral seal would then be produced by circumoral contraction. However, the tongue activity was

Fig. 4.—Photographs of the patient after treatment, showing her *above* with lips at rest and *below* with the lips held together.

unmodified and it was accepted that the thrust was an endogenous one.

This case serves to illustrate the limitation of treatment imposed by soft-tissue morphology where the activity is unaltered by treatment. However, even where an adaptive or habit thrust existed in combination with the skeletal factors, as in this case, the prognosis would still have been poor.

Acknowledgements

I would like to thank Professor C. F. Ballard for permission to publish this case and also the Photographic Department of the Eastman Dental Hospital for preparing the slides.

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DISCUSSION

The Chairman (Mr. A. G. Taylor) asked whether there was any family history in this case which had such a complicated aetiology.

Mr. I. F. Davidson said that he had not seen the parents, because the child had always attended on her own. There was no record of the point in the notes.

Dr. J. R. E. Mills thought that the case could be explained on skeletal factors. The patient has a very marked Class II skeletal pattern. Consequently, to correct the marked overjet, it had been necessary to tilt the upper incisors lingually to an excessive extent. The lower part of the face was also unusually long with the result that the line of the lower lip was too low to retain them in this unnatural position and they relapsed.

Mr. I. F. Davidson said he would have to agree very largely with Dr. Mills that, even apart from the soft tissue, the patient's skeletal morphology weighed heavily against her.

Mr. N. L. Hill said that when Mr. Davidson had started to deliver his paper he had thought that the case was untreatable. It raised the interesting question whether many cases should be labelled as untreatable or whether orthodontists should try to treat them. Did the patient think it was worthwhile?

Mr. I. F. Davidson (in reply) said that the patient had been pleased, but many patients would not think it was worthwhile after having attended for a couple of years.

Dr. W. J. Tulley endorsed what Dr. Mills had said. This type of problem occurred in about six per cent of the child population. The abnormal function of the soft tissues would have been eliminated if the morphological features of the hard tissues could have been converted, although that was not possible.

Mr. B. B. J. Lovius asked if the patient had had a hearing test at any stage? Had she received any speech therapy? She was obviously relapsing at a considerable rate. How did Mr. Davidson know from his last models that the patient was stable and would not relapse completely to her original state?

Mr. I. F. Davidson (in reply) said that the patient had not had any treatment for her fairly mild sigmatism. The patient had not had a hearing test.

The patient had relapsed up to 1961. She had been seen at the end of 1963 and she had not relapsed any more than was shown on the final models. His opinion was that she would not relapse any more.

Mr. A. S. Lewis said that he had noticed that the upper first premolars had been extracted and the space closure appeared to be reasonably satisfactory. Did Mr. Davidson feel that he had done the patient some good by this, disregarding the aesthetics?

Mr. I. F. Davidson (in reply) said that this patient was an ideal example of a very short maxillary dental base. His opinion was that it was probably a good thing that she had lost two teeth.

Mr. C. D. Parker asked him whether he thought the case showed that, although the mechanism of producing an anterior oral seal could not be changed, some reduction in overjet was still possible because of the influence of crowding. The crowding in this type of case was the bar to a spontaneous reduction in the overjet and, therefore, had to be relieved.

Mr. I. F. Davidson said that whatever appliance therapy was used, he thought that the tongue would have brought the teeth forward more or less to where they were now, irrespective of where they had been placed and how long they had been held.

SIMPLE FIXED APPLIANCES

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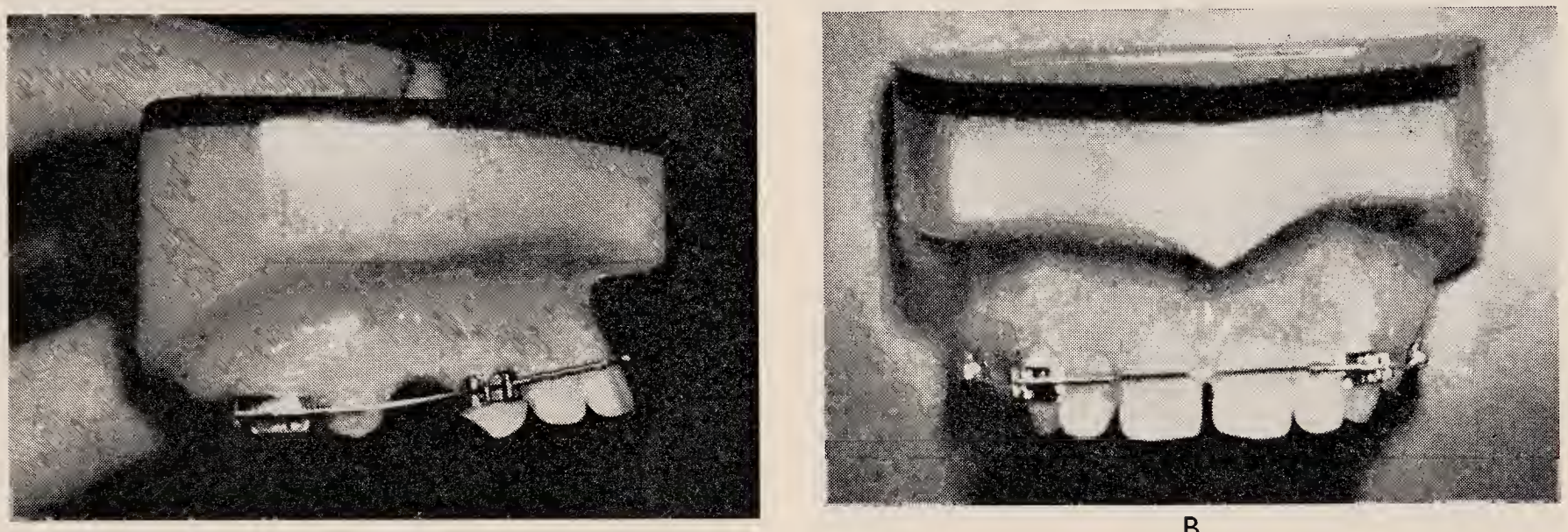
By ' simple ' fixed appliances is meant those in which only the minimal number of teeth are banded, and the term ' miniband ' might therefore quite properly be applied to them. They are, generally speaking, of the type described by Fletcher (1961) as ' rigid ' appliances, and for this reason, can be constructed in the laboratory by a technician, leaving only the bands to be made in the mouth. Thus surgery time is greatly reduced, and it is by developing such methods that we are most likely to bring orthodontics within the reach of the very large numbers of children who are in need of it. In any case, the quality of the result is not necessarily proportionate to the number of teeth banded or to the complexity of the appliance.

A few such appliances which have been thoroughly tested clinically and have been found useful will, therefore, be described.

The basic appliance is shown in *Fig.* 1, and is constructed from the parts shown in *Fig.* 2.

$\frac{63|36}{}$ are banded and attachments fitted to them. Selmer Olsen buccal tubes are welded to the $\frac{6|6}{}$ bands and double-slotted brackets to the canine bands. These latter brackets consist of a ripple-type bracket welded vertically and then slotted with a disk to take a 0·5-mm. arch, which is then held in place by a simple soft-wire ligature passed up and down the tubes. This type of attachment permits freer movement of the bracket along the arch, while at the same time preventing undue tilting of the canine.



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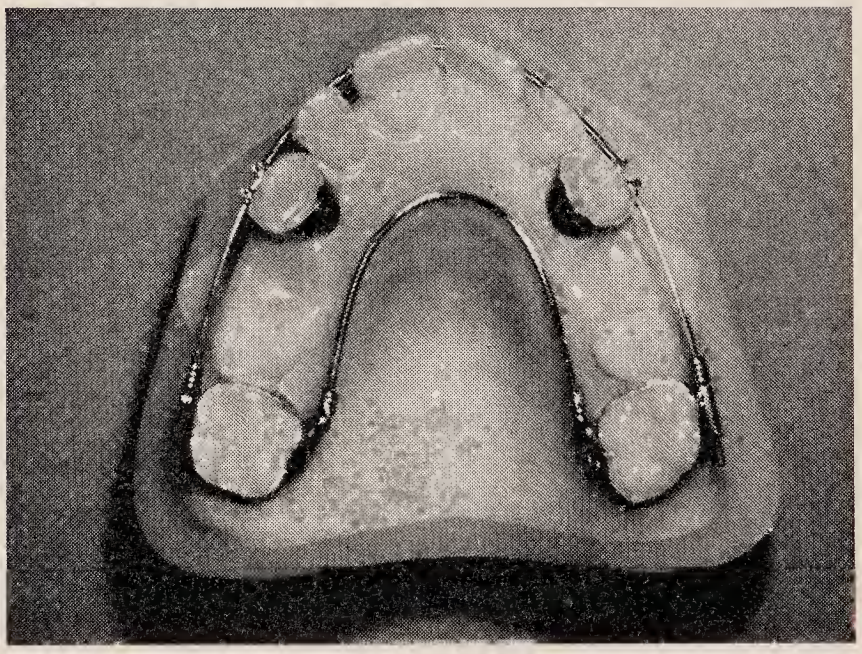


C

Fig. 1.—' Basic ' appliance for retracting $\frac{3|3}{}$, A, Side view, B, Front view, C, Occlusal view.

The arch wire is drawn into end tubes and these are fitted with friction-fitted latches before passing into the Selmer Olsen buccal tubes on the bands.

The rigidity of this form of attachment helps to minimize tilting of the first molars. The force is supplied by means of coil springs made from 0·006-in. spring wire and activated by friction-fitted stops which are readily adjustable to vary the tension of the spring.

Presented at the meeting held on 12 October, 1964.

With this appliance it is found that canines can be fully retracted in 8–12 weeks and with only two or three visits for adjustment.

In Class II, division 1 cases the subsequent retraction of the incisors can be carried out by substituting for the 0·5-mm. arch wire a 0·9-mm. high labial bow carrying a 0·4-mm. apron spring. This appliance is shown in *Fig.* 3, and can be constructed by a technician on a model cast from an impression taken over the bands. It is not usually necessary to remove the bands for this purpose, which results in a saving of surgery time. The appliance is very effective and rapid in its action, incisors being retracted in well under 12 weeks in most cases with little or no adjustment. If carelessly fitted, however, it can cause ulceration in the labial sulcus, but this tendency can be reduced by fitting lengths of plastic or rubber tubing over the labial bow.

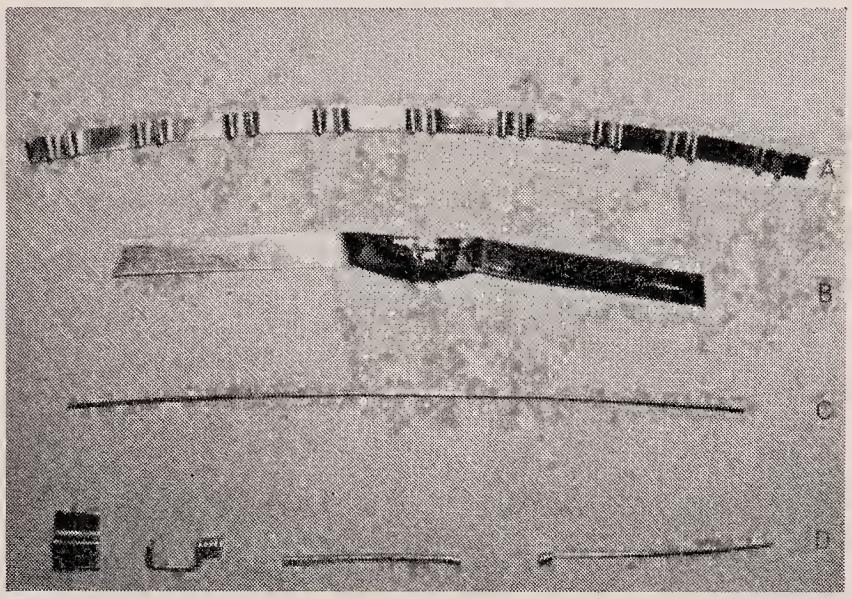
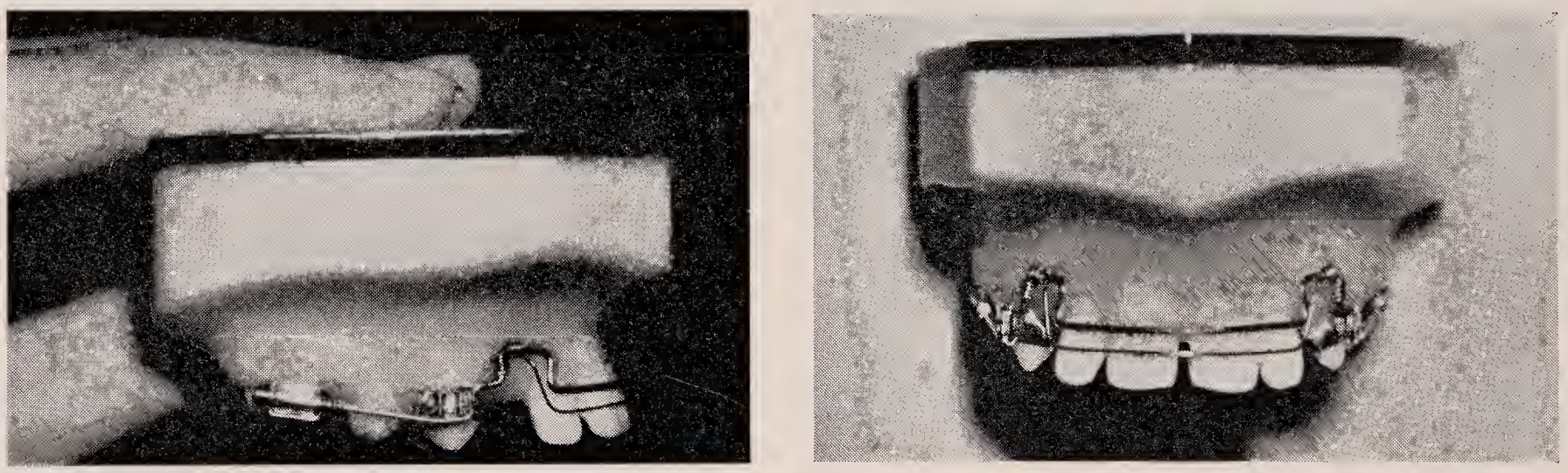


Fig. 2.—Prefabricated parts of appliances. A, Ripple brackets. B, Brackets welded to contoured canine band. C, 0·5-mm. arch wires. D, From left to right Selmer Olsen tube; 0·55-mm. latch; 0·006-in. coil spring; 0·35-mm. friction stop.

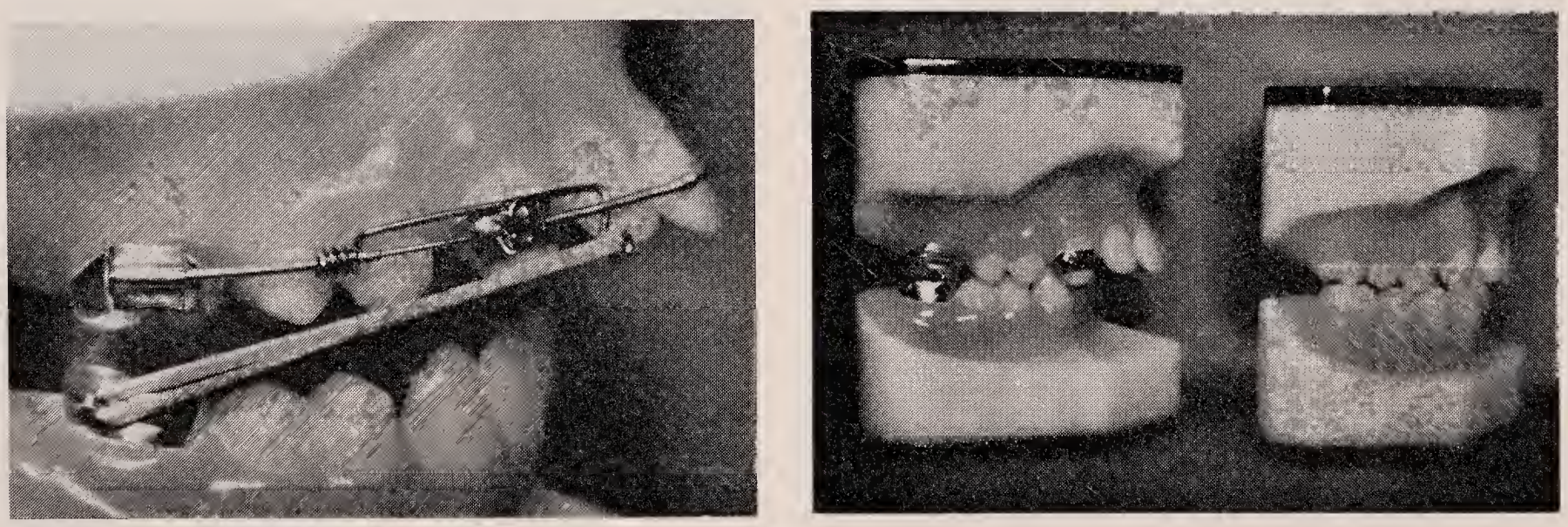
Fig. 4 shows a variation of the appliance which has been known in Bournemouth as the ' Conduit ' appliance. This does not refer to any engineering principle, but merely to the name of the first patient on which it was used!

It is employed in cases where space is short and where no forward movement of upper posterior teeth can be permitted. In the case shown, $\frac{6|6}{6|6}$ have already been extracted and considerable



A B

Fig. 3.—Fixed apron spring. A, Side view. B, Front view.



A B

Fig. 4.—A, ' Conduit ' appliance using intermaxillary anchorage to retract $\underline{3|3}$. B, Case treated with ' Conduit ' appliance.

forward drift of $\frac{7|7}{7|7}$ has occurred. The potential space exists in the arch, however, and the appliance is so designed that every part of the force is used to beneficial effect, the reaction from the coiled springs being taken by the lower rather than the upper posterior teeth, and it should be noted that upper and lower lingual arches are fitted to prevent undue tilting or rotation of the molars. With this appliance it is often possible (as shown in *Fig.* 4B) to achieve normal relationship of the buccal teeth without moving each tooth individually. After retraction of the premolars and canines the friction stops can be adjusted so that the intermaxillary force is transmitted through the labial wire to the incisors, which can then be retracted with the same appliance.

A further variation of the technique is shown in *Fig.* 5. Here the incisors are being moved laterally to correct a centre line shift and to accommodate a canine which is inclined distally. In such cases, mesial movement of the incisors rather than distal movement of the canines is frequently required and the coiled spring with friction-fitted adjustable stop is very suitable for carrying out the necessary tooth movements.

A

B

C

D

E

Fig. 5.—A, Lateral movement of incisors by successive banding. $\underline{321|}$ have been banded and moved successively to the right. B, $\underline{|1}$ has been banded and moved to the right. C, $\underline{|2}$ has been banded and moved to the right. D, $\underline{|3}$ has been banded and alined. E, Appliance removed.

As will be seen from the illustrations, the teeth are banded successively and the coiled springs adjusted to move, each one in turn, the required amount. This appliance is rapid in action and

economical in surgery time and has been found to be very useful in this type of case.

All these appliances have been in constant use for many years, and it is the author's hope that this publication will be of assistance to those who like himself are faced with the problem of satisfying the ever-increasing demand for orthodontic services.

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DISCUSSION

Mr. A. J. Walpole Day said that he had been going to ask, on seeing the first appliance, how Mr. Hooper removed the palatal arch when it got embedded in the palate, but he thought this would be unkind.

With regard to the second appliance shown, he noticed that the 0·9-mm. arch wire was below the nick in the attachment and he wondered why this was so. It looked as though it might be to stop the canine coming forward. Was there some other reason why this was not taken through the slot in the first place?

Mr. Hooper replied that the slot was cut for 0·5-mm. wire and this was 0·9 mm. He had never thought of enlarging the slot. The rigidity prevented the tilting that might otherwise occur.

THE TIMING OF ORTHODONTIC TREATMENT IN RELATION TO PSYCHOLOGICAL DEVELOPMENT

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A MORE modest and appropriate title would have been, ' Some Thoughts on the Timing of Orthodontic Treatment in relation to Psychological Development '. I should like this paper to be regarded as a preliminary to further investigation.

It was in 1949 that the Society was last addressed on the subject of child psychology. Mr. Russell Marsh delivered a kindly and good humoured paper entitled ' Multum in Parvo '. This concerned the recognition of types of patient and emphasized that we must consider the whole child, not only the malocclusion.

My purpose is to suggest that if an orthodontist has a knowledge of his patients' emotional problems, then he may be able to select those patients who need special help. He may also increase the efficiency of his clinic. I shall try to avoid unfamiliar terminology, taking as a warning Freud's (1935) own remark, ' A writer who brings in the phrase, ' Inferiority complex ' thinks he has satisfied all the demands of psychoanalysis and has raised his work onto a higher psychological plane '.

Most of our patients desire or accept treatment because they, or their parents, wish for appearance to be improved. In the literature there is much work which concerns the relationship between appearance and personality. Whilst some authorities believe there is a direct relationship, others dispute this and place importance on home background.

Adler (1930) spoke of the perception in oneself of organ inferiority, saying that a physical handicap may cause insecurity. Freud (1935) propounds a theory of identification with the ' super ego '—a striving for perfection. He places a strong erotic basis on feelings of inferiority. Root (1949) states that ' the first and foremost psychological effect of dento-facial deformity seems to manifest itself in a sense of inferiority, self-consciousness and shame '. Hadfield (1962) believes, ' if there is one thing above all that a growing boy or girl dislikes it is being different '. He says that self-consciousness and inferiority may follow them throughout life, even when they have outgrown their physical oddities. (Only last week a parent told me that occasionally he covers his mouth with his hand to hide the ugly teeth which were extracted twenty years ago.)

However, Hadfield goes on to say that the conditions which the parents provide very largely determine what the child is going to be. Jung (1953) showed how closely the psychology of the child is linked with that of its parents. To the question, ' Does a defect in itself make a child seriously self-conscious or ashamed? ' Spock (1964) answers, ' Generally speaking, No '. He believes that appearance should be taken as of no great importance, and states that the important factor in making a person grow up happily is having parents who thoroughly enjoy and approve.

Research carried out in this field indicates the desirability of a good family environment.

Ogden (1959), in the examination of Borstal inmates, found there was basically a lack of moral values and practical example in the family circle. A medical team then treated fifty-five delinquents who had squints, nasal deformities, and other disabilities. Two years after release from the institution, there were 54·5 per cent of the treated men free of re-conviction compared with 31·5 per cent of all untreated cases. Ogden thought that part of the success was probably due to the demonstration that society was prepared to help.

Baker and Smith (1939), at the University of Pennsylvania, analysed 312 people who requested plastic repair of facial disfigurement. The patients with the most sensible attitude to their deformities usually had strong family ties and secure home backgrounds. The investigators found that there were three main groups: (1) The well adjusted, who requested improvement to major deformities. They did not expect too much.

Presented at the meeting held on 12 October, 1964.

They usually had secure home backgrounds. (2) Those with inadequate personalities who retreated behind their handicaps as a defence. The removal of a deformity is the removal of a defence in these cases. (3) The psychotics, who focussed on minor facial abnormalities.

I think we should be aware of the two latter groups, but I do not presume to give orthodontic patients (2) and (3) classifications.

Watson (1964) investigated the personalities of boys with repaired cleft lip and palates. He used the Rogers inventory and in his tests found no significant differences between the personalities of cleft, handicapped, and normal boys. Smith (1958), in a monograph dealing with the validity of such tests, explains the difficulties in arranging them. She finds the Rogers inventory acceptable.

Ash (1951) in ' The Psychosomatic Evaluation of the Orthodontic Patient ', makes a study under headings such as: habitual motor activity; social attitudes; scholastic status. He suggests that a child who presents an adverse picture in this assessment is likely to be uncooperative and to waste surgery time.

I have encountered fidgeting, hyperkinetic, nailbiting patients who have repeatedly broken appliances. The recognition of this type of child enables one to use simple, sturdy appliances, or to curtail the treatment.

A particular group of patients may fail to attend; damage or lose appliances; sometimes be surly or ill-mannered. This group one may refer to as ' spoiled '. In my experience, these children often identify themselves by their unpleasant attitude to their parents, not necessarily in the surgery, but in the waiting-room or where they think they are unobserved. The parents of such children often identify themselves by the request for treatment and appointments at times unacceptable to the staff of the clinic.

I have found that the excessively uncommunicative child should be treated with care and sympathy. He often has a disturbed family background of imminent divorce, separation, neglect, or insecurity.

THE TIMING OF TREATMENT

Before the age of 8 years, children are not usually very concerned about their dental appearance. However, at 8 to 10 years comes the desire to conform (Hadfield, 1962). Moore (1963), discussing the correction of nasal deformity, says, ' This is not a problem as a rule until the child is over 8 years of age. The desire to look normal may then be so strong that the surgeon is obliged to attempt a partial correction.' I think that the child who requests treatment at this age, and who is disturbed by his appearance, should take a place of priority in our clinics. When I asked at what age such a child should be treated to its best advantage, a psychologist who herself had a marked protrusion of spaced upper incisors said, ' At once '. A shy, introverted child with ugly teeth may not mix well at school and may be teased badly. I have known the confidence and happiness of such children to increase as soon as they are re-assured that treatment is possible. Some children can accept a dental deformity whilst they are at junior school, but fear the new environment of a senior school. They request treatment shortly before their entrance to the new school, and usually are good patients. From the age of 8 to 12 years, most children make good and co-operative patients.

With regard to the adolescent, Spock (1964) affirms, ' He may exaggerate any worry about any defect '. Hadfield (1962) states that the adolescent may become very moody. The desire to attract the opposite sex develops. Hollingworth (1933) explains that it is uncertainty of status which causes much of the adolescent's difficulties. He also says that physical beauty, especially of the face, is the most potent stimulus to sex activity. Salzmann (1957) says, ' The most difficult patient to treat is the adolescent. When the condition is disfiguring he is torn between ' getting the teeth straight ' and orthodontic appliances. This type of patient requires a magic wand, which, with no effort on his part, will improve his appearance immediately.

Parents are faced with increased problems. Busemann (1943), in a study of girls aged 9 to 17 years, found a marked increase in bad social relations with the family from 12 to 14 years, the peak being at the age of 13. This corresponds to the 15-year-old age-group in boys.

The adolescent may be an exceptionally co-operative patient, aiming to improve his appearance at all costs, or he may reject the whole idea of appliances. He may be a considerable nuisance in commencing treatment which he does not complete. He may request the removal of bands or the similar modification of a removable appliance. A somewhat similar attitude is found in some adults to their own orthodontic treatment.

I suggest that a child who is unhappy about his appearance is probably unhappy and insecure because of his home environment. It is therefore necessary for the orthodontist to see the parents in order to assess their attitude to the dental deformity and to the child. The unhappy child should receive treatment as early as is reasonable. The parents should be made aware that possibly some of the child's unhappiness is caused by their own attitudes.

It is not my intention to suggest that we should dabble in psychology. The orthodontist sees and treats a young patient at regular intervals for a year or more. It is possible that during this time he gives the child more individual attention and

encouragement than is given by any other adult but the parent. On occasion it may even seem to the child that the interest in him shown by the parent is less than that shown by the orthodontist. I think we should realize these circumstances, and take advantage of the situation to be firm and friendly with the patient and parent. Possibly both need re-assurance and encouragement as much as they need orthodontics.

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DISCUSSION

The President said that he found the subject an interesting and provocative one. He had recently met an American child psychiatrist who had a theory concerning the reason why American parents were so keen to get their children orthodontic treatment, even in mild cases. The orthodontist could always make some improvement, whereas allergies and other ailments could not be so positively treated.

Mr. D. A. Dixon said that Mr. Pettman reported a number of cases of individuals who had been psychologically improved by treatment, but on this possibility there was a division of opinion in the literature between psychologists and clinicians. Recently a study had been carried out by Drillien in Edinburgh and had revealed that children with facial abnormalities showed no difference whatever in behaviour from ordinary children.

It was the time of puberty when aesthetic considerations were the most vital and just before puberty when, clinically, orthodontics was often indicated. He asked if Mr. Pettman felt that there was a significant number of adults who had personality changes due to dental deformities which had not been corrected before, say at 12 or 13 years of age, and were there any simple methods by which it could be determined whether a child should be treated early rather than treatment left to a later age.

Mr. Pettman said that he thought the reason for statisticians tending to disagree with clinicians was because clinicians, including orthodontists, tended to remember the dramatic cases, whereas statisticians dealt with many other cases besides.

He could not answer the question concerning adults.

There were some projectivity tests used by Harris and others. These tests consist of a series of questions, words, or pictures, to which the child is asked to respond. However, there were so many variables that had to be considered and accounted for that it was not usual for orthodontists to carry them out. It was necessary to carry out these tests under standard, optimum circumstances. The advice of an educational psychologist was recommended, and information was required from school and parents. The child's intelligence, social background, health, and school attendance had also to be considered.

It was therefore possible for an orthodontist to administer such a test and to assess the results on the grounds of commonsense, but his interpretation could not be considered as precise by scientific standards.

Mr. J. H. Gardiner recalled a father who confided privately that he was a little ashamed of his son because he used to run away from fights; as the father used to be a boxing champion, this naturally hurt his pride. After a year's treatment, the father had come back specially to say that the boy's school reports had improved, that he was very much brighter at home, and that now he would take on any kid in the street.

Mr. D. H. Oliver asked Mr. Pettman if he had devised any particular means of dealing with the naughty parent and particularly the naughty father. Fathers were generally worse than mothers, but it was a very big problem in many cases and he wondered how Mr. Pettman coped.

Mr. Pettman said that he put it to them in a way that suggested that the child needed the encouragement at home to counter unhappy experiences among children at school. Of course, the home was the real source of the trouble.

Mr. Oliver asked if it had worked and Mr. Pettman replied that he did not know.

Mr. W. A. Nicol asked Mr. Pettman whether, in dealing with or investigating unhappy home backgrounds, he found any significance in whether both parents worked or not.

Mr. Pettman said that he had indeed!

Mrs. E. M. N. Carvalho asked if Mr. Pettman thought that there was a psychologically ideal time for treatment, apart from the time when both child and parents wanted treatment. She found that parents wanted treatment when the child was about 8 when, often, teeth were not erupted and treatment could

not be given. Parents did not want treatment between 11 and 13 when she wanted to do treatment, because the children were changing schools, and she did not like treatment when children were about to take G.C.E. examinations. There did not seem to be much time left.

Mr. Pettman said that he thought the best time from the psychological point of view was when children were in the submissive, conforming age-group, when they were willing to accept treatment. This was at about 10 or 11 years.

Mr. E. K. Breakspear said that the problem of the uncooperative parent was important because there was conflicting loyalty in the child.

Mr. D. G. Bunker asked Mr. Pettman at what age he considered discouraging a child from sucking his thumb and how persistent one should be in this before one got knocked down by the psychiatrist.

Mr. Pettman said that he would discourage thumb-sucking if it was interfering with the treatment and he would discourage it very gently by explaining what the interfering sucking habit was doing.

MECHANICAL FAILURE

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THE title of this short communication is purposefully vague. Perhaps it should be ' Mechanical Failure or Some of the Things we would rather not have done'.

The modern revolution in orthodontic thinking has resulted in widespread understanding of the aetiology of malocclusion and a greater understanding of the problems of diagnosis and treatment planning. There has been much greater emphasis in the teaching hospitals on the subject of orthodontics, and the new graduate, on qualifying, is fully versed in the methods of diagnosis and treatment planning and the theory of tooth movement.

However, many courses of orthodontic treatment fail to achieve the practitioner's and patient's desired result. There are, of course, many causes of such failure to complete treatment, but I confine my remarks to what I believe is the main cause, that is, the faulty design or manufacture of the appliances used, to obtain the necessary tooth movements. The most important single factor in the design of any orthodontic appliance is that it should be comfortable for the child to wear and simple to insert. In the majority of cases where appliance treatment is not going well the base plates are far too thick. I would suggest that the risk of breakage of an appliance is no greater when the base plate is as thin as possible than when it is comparatively bulky. Breakage of the base plate in the mouth is extremely rare. When the patient attends and says, ' It broke ', he usually means he either sat on it, trod on it, or the dog got at it.

If there is not adequate retention of the appliance, then it will be uncomfortable and the patient unlikely to tolerate it. Despite the care with which Adams (1964) describes his method of cribbing the various teeth in his book, it is still comparatively rare to see them made correctly. In some cases the design of the crib is such as actively to propel the plate from the mouth rather than to retain it. Appliances are occasionally seen without any method of retention at all.

Breakage of the wire forming the crib does occur, usually at two well-defined places. There is no doubt in my mind that the chief cause of breakage of crib wire is faulty fabrication resulting in metal fatigue due, in the one case, to the crib being bitten on by the opposing teeth and in the other, to over-bending of the wire by the technician.

Even the simplest of appliances needs to be carefully designed. The oral screen which is made to the models in occlusion not extended deep enough into the sulci nor far enough back in the buccal segment region, is not only useless but may, in some instances, worsen the malocclusion. In one case the upper incisors were actually lying outside the screen when it was worn. As you all know, the oral screen should be made to the models in the rest position and extended as far as possible into the buccal sulci and at least as far back as the distal surfaces of the first permanent molars.

When active retraction of the teeth is required, it is, of course, important to clear away the base plate adequately from behind the tooth to be moved. The base plate needs to be cut well away from the tooth if speedy results are to be achieved. Failure to do this results in slow and painful progress.

Failure to adjust bite platforms in order to make the plate wearable is another important factor.

In any case requiring gagging of the bite, the gagging should be only just sufficient for the tooth movement required. The rather untidy appearance of the appliance in which the cusps of the posterior teeth are biting through the bite platform is, perhaps, distasteful to many technicians and some dentists. It is, however, much more, comfortable for the patient and failure to appreciate this point may result in the appliance not being worn.

Multiple action appliances are often seen. These are usually uneconomic, inefficient, and ineffective.

I would suggest that a good general rule in appliance design is that one plate be used to achieve one tooth movement. I find by the time this has been achieved the appliance is becoming a rather sorry-looking affair and it is far better to change it to achieve the next tooth movement required.

There is also, I think, a tendency to use wires far heavier than those that are actually required to achieve the necessary tooth movements. It must always be remembered that a heavy wire has a very much shorter range of action if it is not to put too much pressure on the tooth and cause

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damage to the supporting structures. Fine, unsupported springs are, however, relatively unsuccessful in use as they are so easily damaged and I would recommend the use of fine springs supported in tubes in order to obtain the rigidity required and the gentleness of action in order to produce a long range of movement.

The failure of screws to produce the hoped-for tooth movements can occasionally be put down to the screw turning itself back when the appliance is inserted. This is particularly noticeable on brass screws, where the thread appears to be easily worn and the actual act of inserting the appliance into the mouth judders the screw back part of the way that it has been opened. This can easily be checked by making a note of the number of turns the screw should have been opened from a closed position when the patient is next seen. If this does not correspond at the next visit, then either the patient is not opening the screw as instructed or it is turning itself back whilst the plate is in the mouth. The accurate positioning of screws is, of course, vitally important. They not only have to be positioned so that they move the teeth in the correct direction, but the technician must take care to see that, when the screw is positioned and opened, it does not result in the plate lifting off the palate or, worse still, pressing hard into the palatal mucosa.

I hope that I have shown some of the simple things that can go wrong and make treatment unsuccessful.

So often it is just one small fault in the design or manufacture of an appliance which tips the balance between success and failure.

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DISCUSSION

Mr. S. G. McCallin wondered whether Mr. Broadway would agree that one of the main reasons why technicians produced these thick plates was because they used a hard, brittle wax, whereas, if a more pliable wax were used, it was easier to produce an appliance of thickness equivalent to one thickness of wax.

He also asked if Mr. Broadway would agree that there was another factor which caused fracture of the Adams clasp, namely that technicians tended to make the arrow at the wrong level on the buccal surface of the teeth, so that when the appliance was inserted in the patient's mouth, it did not fit. The orthodontist worked it backwards and forwards to make it fit, and this was what caused fracture. He was afraid it was true that the 0·7 wire as bought from the supplier was often more brittle than any other size.

Mr. Broadway said he thought that some technicians were adverse to having anything except a perfectly smooth plain surface. If there was a wire, it must be completely embedded; they could not bear to see a little bump. This was why they tended to make appliances thicker than was necessary. Most of the problems of fractured clasps seemed to occur when the appliances were made by technicians who did not make many Adams clasps.

A member said that a new technician always pinched the arrowhead to make it tighter by putting pliers across it. He had stopped him from doing this and had no further trouble.

He wondered whether the fracture in the second appliance shown occurred because the acrylic came right up to the upper incisors. If the acrylic was trimmed behind the incisors, in his experience this fracture did not seem to occur.

Mr. Broadway said that he was firmly convinced that the fractures only occurred from the plate being trodden on! Mr. Hooper had put him on to the treatment of the fractured Adams clasp a long time ago. You merely removed the bridge and left it as two free-ended arrowheads.

Mr. H. E. Wilson said that some patients could complete their treatment without ever breaking a clasp while others returned again and again with breakages. In these cases the appliance was often lying on the tongue and not in its proper position in the arch. When this habit ceased so did the breakages.

With regard to the design of the oral screen shown by Mr. Broadway, in his opinion, it was too close to the gum in the lower labial sulcus. It should stand right away and not almost touch as Mr. Broadway's appeared to do.

Mr. A. J. Walpole Day asked if Mr. Broadway had tried any heat treatment of the crib after bending. Since a well-known American company had come over and shown how to heat treat metal, he had had his technicians heat treat it after bending. It still fractured where it entered the acrylic if it was not a good fit.

Mr. Broadway asked if this heat treatment was for annealing it or making it springy.

Mr. Walpole Day said that the heat treatment removed the stresses in the wire caused by bending, but did not anneal.

Mr. L. H. Russell wished to make a point in defence of the ' Christmas tree '. Individual movement of the springs by bringing them into play one at a time was the normal thing with this type of appliance, which he thought was inspired by economy.

Mr. Broadway said that in his hands, he found that if four or five springs were put on an appliance, by the time one tooth movement had been achieved, the others were pretty battered and did not work as efficiently as if a new appliance was made. He thought it was false economy.

Dr. J. R. E. Mills noticed that all Mr. Broadway's appliances had labial bows on them; what were these for?

Mr. Broadway said that, at one stage, he fitted labial bows on all appliances in the hope that this would increase the anchorage. He found that one or two without labial bows worked just as well, so now he did not put them on.

Mr. T. Smith asked Mr. Broadway if he had any trouble with dribbling with oral screens and, if so, what he did about it.

Mr. Broadway said he did not use oral screens very much.

MUSCLES, GROWTH, AND THE APICAL BASE*

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In 1923 Axel Lundström published his monograph ' Malocclusion of the Teeth Regarded as a Problem in Connexion with the Apical Base '. In the early portions of that work he traced the evolution of orthodontic thinking and indicated the various theories of the aetiology of malocclusion that had been advanced; he emphasized those that had come to exercise the most profound influence on orthodontics. Chief among these was the concept of functional development which had developed out of Angle's insistence on non-extraction treatment. Although giving full credit to Angle's remarkable successes through the development of his ingenious appliances, he disagreed with the concept that had developed from those successes, viz., that the establishment of normal occlusion led to the growth of bone to support the teeth in the positions attained by treatment. Lundström maintained that the zones of the maxilla and mandible which house the root ends of the teeth were not susceptible to change by orthodontic manipulation. If they were not harmonious in size and disposition with the tooth arches the operator could not hope for a stable result.

It is the intent of this paper to present certain research evidence which not only supports Lundström's thesis, but expands it and to introduce a concept that appears to add an additional dimension to our consideration of the aetiology of malocclusion.

This concept emerged from the gradual recognition that the animal body should be viewed as a collection of systems. Each system has its own specific function which is primary, but in the interest of economy each has been modified to contribute to the functions of others. Each shows an independence in its origins, growth, and maturation as well as an interdependence in functions. This seems to be the case in the area under discussion where the digestive and skeletal systems contribute to each other's functions and development. The teeth constitute the functional link between the two, their root apices being controlled by one system, the skeletal, and their crowns being under the control of the other, the digestive. The highly labile alveolar processes provide an admirable mechanism of adjustment between the two influences. In order to make this conclusion plausible I should like to trace for you the meandering course of my own thinking over these last forty years and indicate some of the experiences that have influenced it toward its present direction.

I completed my course of training under Angle in 1926 and three years later was appointed to organize graduate training in orthodontics at the University of Illinois. Under Angle I was fully indoctrinated in such matters as the normal occlusion of the teeth, the treatment of malocclusion without extraction, and the concept of functional development. As a neophyte teacher I followed these precepts for a number of years. But, by 1938, there had been collected a sufficient sample of cases to permit evaluation of our clinical results by means of the Broadbent-Bolton roentgenographic cephalometer which had been utilized since shortly after the department was organized.

Two of the conclusions drawn from that study are germane to the present discussion, viz., (1) ' Actual bone changes accompanying orthodontic management seem to be restricted to the alveolar process ', and (2) ' There seems to be a definite correlation between success in treatment and growth .'

Two years before the publication of these findings extraction had been brought to the fore again in the United States and the new evidence was seized upon as justification for it. Then during the Thirties and the early Forties, the first longitudinal growth studies appeared, the first by Broadbent (1937) and then that by the author (Brodie, 1941). Both demonstrated the remarkable stability of the skeletal pattern of the head. But, from the start, the word pattern was misunderstood. It was interpreted as meaning something fixed. If it was fixed what chance did the orthodontist have to fit teeth that were too large into it? It seemed to offer an additional

* This study was supported in part by Research Grant D-1468, from the National Institute for Dental Research, U.S. Public Health Service.

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excuse for extraction. And now the attention of the orthodontist focused increasingly on aesthetics.

Eventually, the technique of cephalometric roentgenology began to be utilized in clinical orthodontics. These efforts were directed at the development of various analyses for the purposes of diagnosis and treatment planning. The first of these, by Downs (1948), was followed by a number of others. All were restricted to the lateral film and all were directed at the determination of deviations from a single ' normal ' face, the chief characteristics of which were upright incisors and a straight profile. But even with this limitation the clinicians' attention was finally drawn to the importance of growth—downward and forward growth at least. As a result of the neglect of the frontal film and the clinical observation of relapse, it had become the firm conviction of most orthodontists, and particularly those trained since the re-introduction of extraction, that the dental arch could neither be widened nor lengthened.

But there were those who wanted better evidence than had been offered to support this re-introduction of extraction. They sought objective evidence that would explain the successful maintenance of those cases which had all of the characteristics of inevitable relapse at retention. Chief among these was Milo Hellman (1927) whose growth studies had convinced him that the orthodontist was claiming credit for changes that were more properly attributable to growth.

In the early days of the department at Illinois, as stated earlier, we followed the concepts taught to me by Angle, i.e., we extracted no teeth and although we probably created some protrusions we also had sufficient successes to maintain our faith in much of our earlier teaching. Our

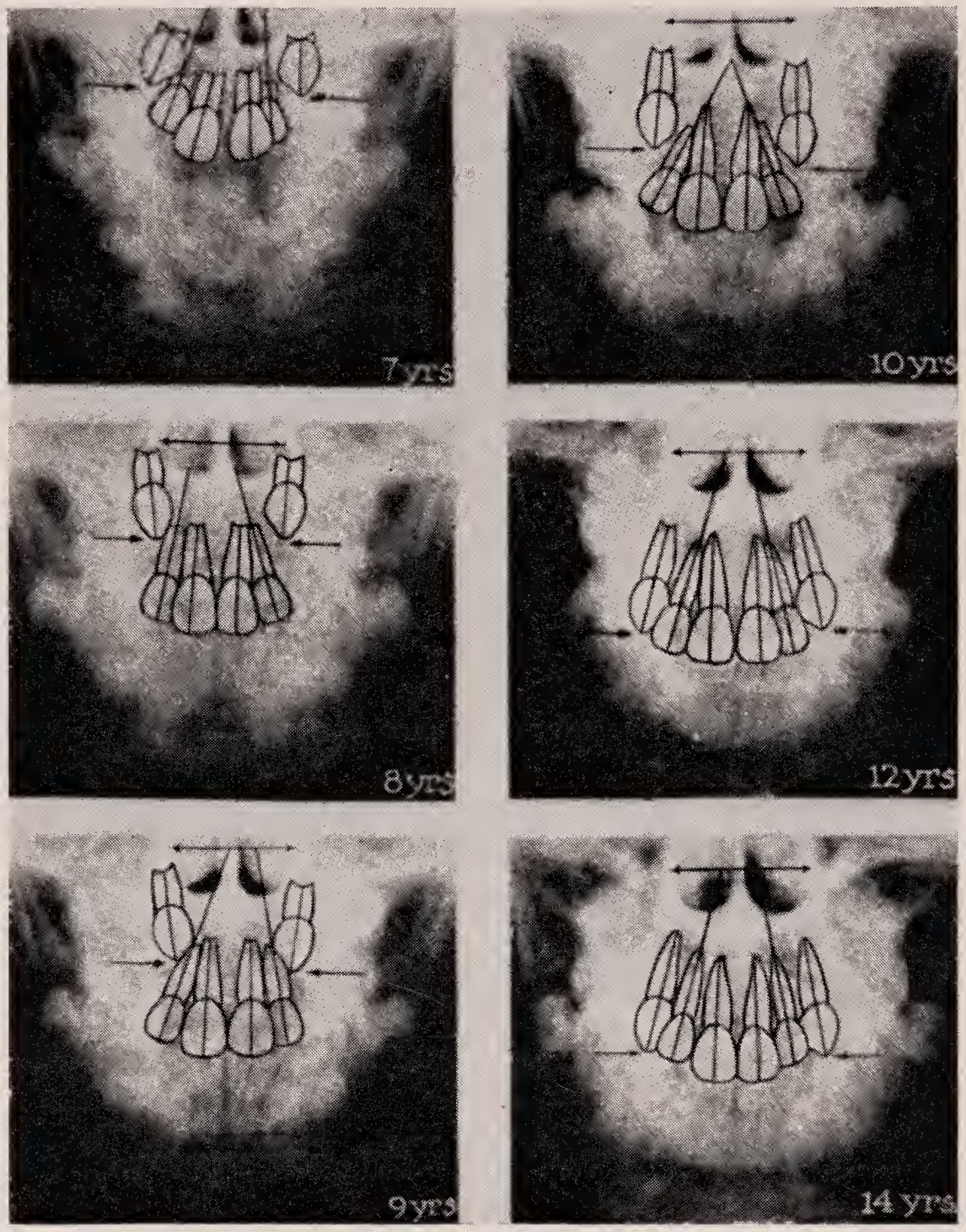

Fig. 1.—Serial frontal X-rays of one individual showing development of, and recovery from, the ' ugly duckling ' stage of eruption. (*Reproduced with permission from Broadbent, B. H.* (1937), *Angle Orthodont.*, **7**, 183.)

appraisal of results in 1938, while it tempered our insistence on the maintenance of a full-complement of teeth, also alerted us to the danger of embracing extraction as a panacea. Further growth studies seemed indicated, indeed these had already produced some supporting evidence.

One of the first of these was Broadbent's demonstration of the ' ugly duckling ' stage of development in his 1937 paper on ' The Face of the Normal Child ' (*Fig.* 1). In that communication he showed how the four maxillary incisors might erupt with their root apices so close together that their long axes took a decided distal inclination only to become normally upright as age advanced. It seemed that only a peripheral growth of the maxilla at the level of the root apices, the ' apical base ' of Lundström, with an accompanying spreading movement of the apices could account for this.

Evidence for such growth, i.e., remote from the tooth crowns, was found in the mandible during many clinical examinations (*Fig.* 2). In those cases in which the four permanent incisors had erupted and the two primary canines were still in place, the intra-oral X-ray films would occasionally reveal deep absorption bays on the mesial surface of the canine roots. These seemed to indicate that the disto-incisal angle of the crown of the lateral had lain in this position prior to beginning its eruption. Films of other children revealed the mesial half of the primary canine root sheared obliquely from apex to gingival margin. We interpreted such findings as indicating that growth had been taking place, but that it was occurring slightly after a time synchronous with eruption.

In 1949 Schaeffer, a graduate student, sceptical of the dogma of the upright incisor, studied the behaviour of these teeth, both upper and lower, in relation to appropriate planes of reference and to each other. The sample consisted of serial records of 47 untreated individuals taken over an 8-year span following the attainment of full occlusion by the incisors. Among the conclusions from the study were these:—

1. 'Each of these angles may increase, decrease, or remain stable during growth.'

2. ' There is no correlation between the behaviour of one of these angles and that of another. Any one of thirteen possible combinations might exist in an individual and all but four such combinations were found in this sample of 47 individuals. '

3. ' Regardless of the behaviour of these axes, the incisor teeth come to occupy a relatively more posterior position to their supporting bones with the growth of the facial skeleton. This is advanced as a possible explanation for the progressive aesthetic improvement observed in individuals exhibiting dental prognathism in their earlier years. '

Schaeffer's study was further supported by the report of the author on ' Late Growth Changes of the Human Face ' (Brodie, 1953). In addition to verifying the findings on the incisors, it pointed out the difference of behaviour of the facial

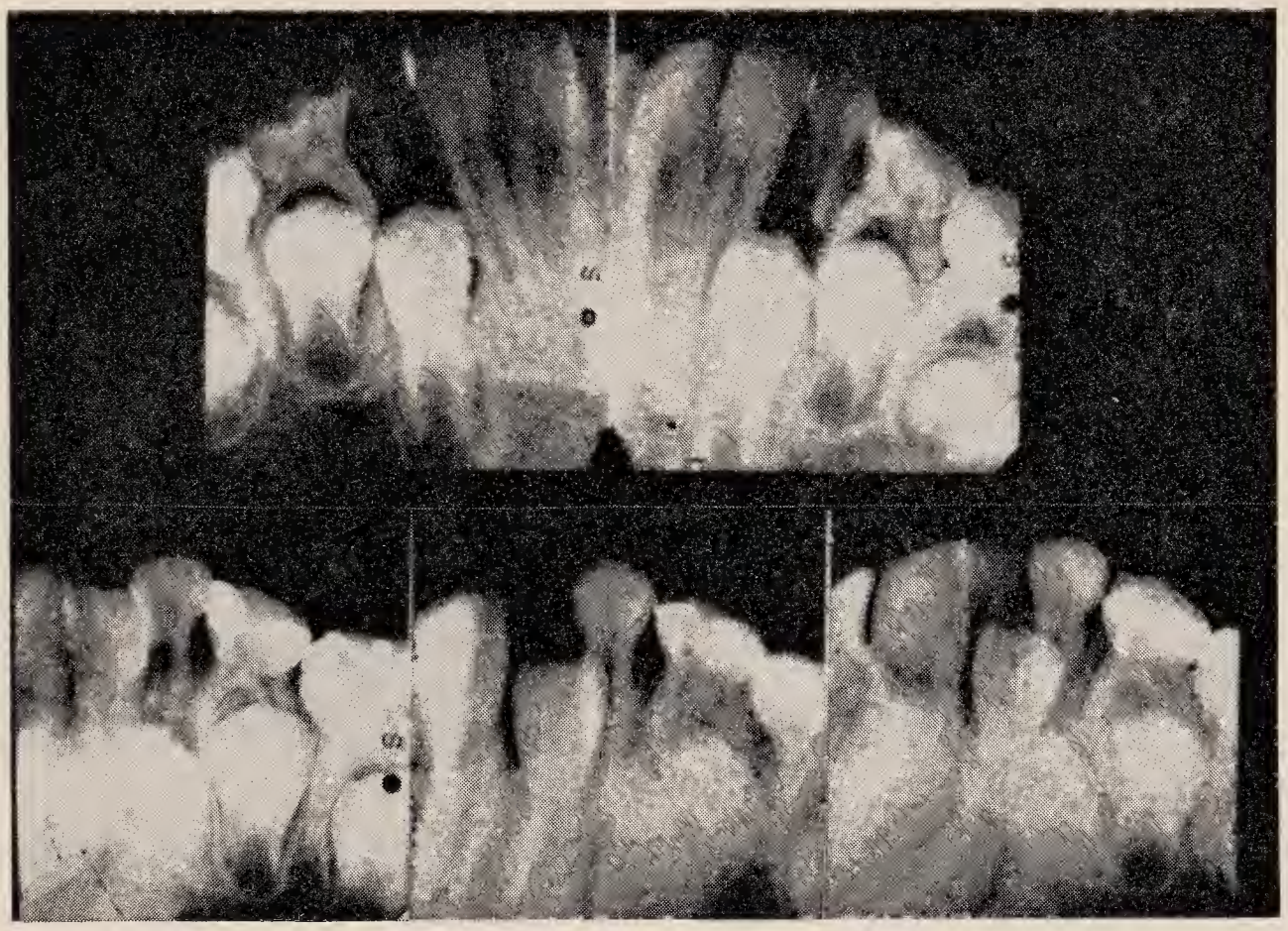

Fig. 2.—Intra-oral X-rays of lower permanent incisors and primary canines showing resorption of canine roots by lateral incisor prior to their liberation by growth of the apical region.

skeleton and that of the dentition during growth which seemed to indicate that the two were responding to different influences. If this were indeed so, the width relations should be similarly affected. This recalled a study that had been conducted by another graduate student.

In 1948 Guy Woods, Jun., had written a thesis on ' Changes in Width Dimensions between Certain Teeth and Facial Points during Human Growth ' (Woods, 1950). He had studied the

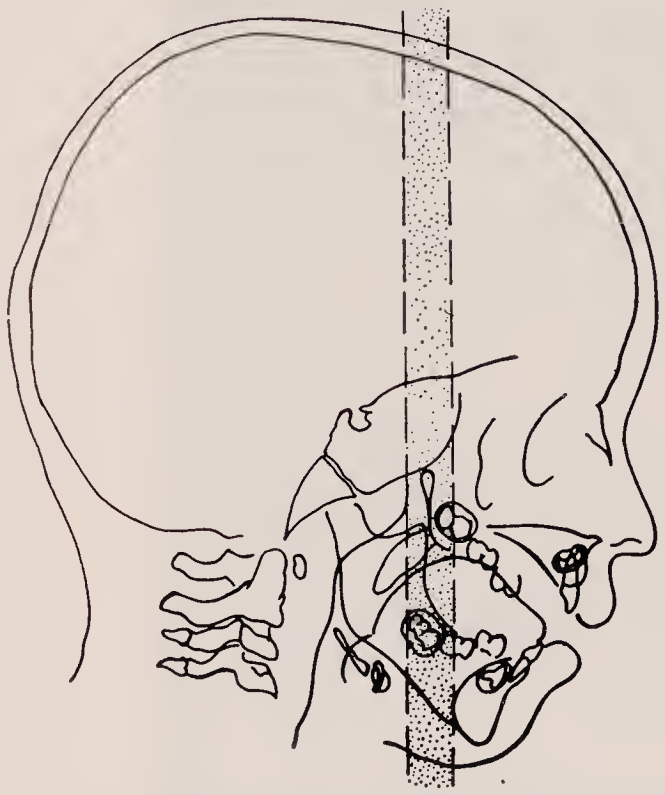

Fig. 3.—Tracing of lateral head X-ray of infant indicating plane of ' cut ' of frontal laminagrams for serial study of width of posterior nasal choanae. (*Reproduced with permission from Subtelny, J. D.* (1955), *Amer. J. Orthodont.*, **41,** 889.)

serial frontal head films of 28 individuals, evenly divided as to sex. He had employed the Wylie-Elsasser compensator, an instrument that permits the determination of the actual dimensions between any points that can be located on both the lateral and frontal head films. Briefly, his findings were as follows: bilateral facial skeletal points such as the bizygomatic and bigonial increased steadily from ages 3 to 15 years, the age span of his sample. Dental arch bilateral measurements, such as bicanine and bimolar, tended to slow rapidly after the sixth or seventh year, although the behaviour of the dental points was far more erratic, i.e., individualized than was that of the skeletal points.

These findings were reminiscent of certain earlier studies. Hellman (1927), Broadbent (1937), King (1952), and Subtelny (1955) had each published findings on a variety of studies, the import of which was that parts lying closest to the vertebral axis were stabilized, i.e., showed little growth after an early age. The width of the nasal choanae, as determined by serial frontal laminagrams of the medial pterygoid plates, showed little change beyond the third year (*Fig.* 3), with a similar lack of increase between the principal anteroposterior points of skeletal attachment of the pharynx, viz., the medial pterygoid plates and the anterior tubercle of the atlas. All of these skeletal parts serve the demands of respiration and deglutition.

Of equal interest to us in the light of the present discussion was the probable explanation of the

Fig. 4.—Plaster and wax model of human head showing course of buccinator muscle and its continuity with the superior constrictor of the pharynx. (Model by A. Goldstein.)

statement by clinicians that the width across the palate was greater in unoperated cleft lip and palate children than in normals. Equally interesting was the finding that the closure of the lip alone by surgery was followed by a decrease in the width of the cleft. This was thought to result from the establishment of more normal muscle pressures against the periphery of the maxillae.

It has long been accepted by orthodontists that there are muscle forces constantly acting on the dental arches from opposite directions, the tongue pressing outward from within and the lips and cheeks pressing inward from without (*Fig.* 4). The basic muscle of the lips and cheeks is the buccinator, which takes attachment from the outer surfaces of the maxilla and mandible in the molar region. Anteriorly it runs relatively free of direct bony attachment, around to join its mate of the opposite side together with certain other muscles which have for their function the modification of the mouth opening, the lips.

Posteriorly this muscle crosses from the buccal to the lingual sides of the mandible and maxilla and takes its main attachment from the top to the bottom of the pterygomandibular raphe. This is the same fibrous structure that gives origin to the superior constrictor of the pharynx, the

bilateral width of which is stabilized early. Hence, there is a continuous muscle band running around the denture and fastened behind to the pharyngeal tubercle of the occipital bone and constricted at the pterygomandibular raphe. If we imagine this muscle sheath independently, i.e., minus the bony maxilla and mandible, we have no difficulty in identifying it as the forward end of a muscular tube which rises from the oesophagus, makes a right-angle bend at the level of the palate, and runs forward to enclose a pouch, the mouth. This pouch contains the tongue, the teeth, and the alveolar processes.

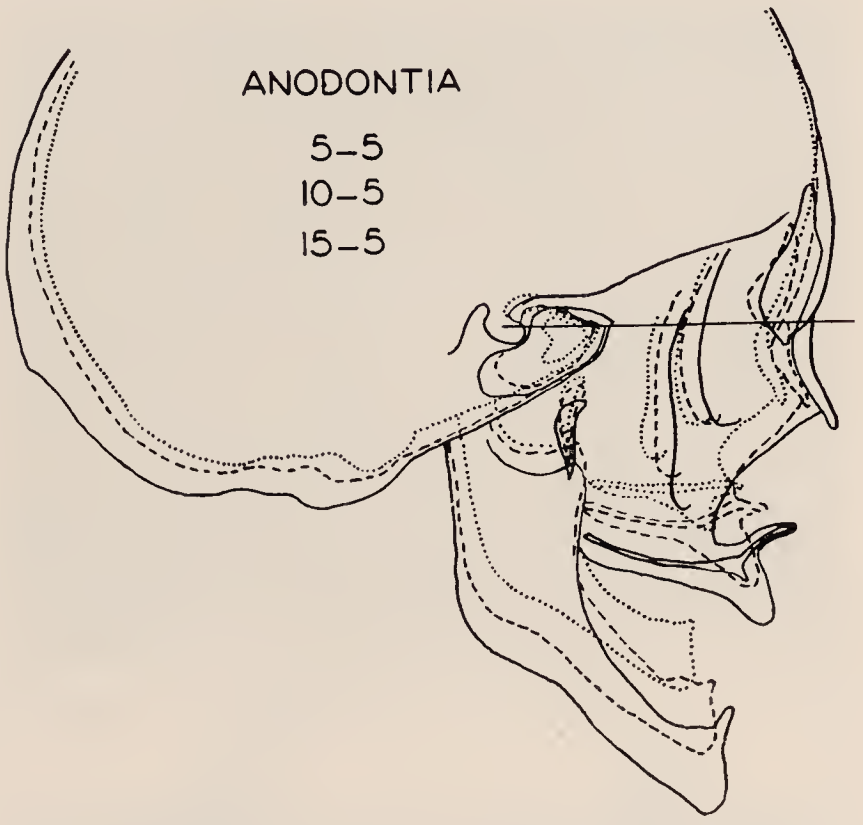

Fig. 5.—Tracings of serial cephalometric head X-rays of individual with anodontia.

If, on the other hand, we visualize the jaws minus the muscles (*Fig.* 5), minus the teeth and alveolar processes, we recognize the conditions seen in anodontia, in the infant and in senility. Our knowledge of the growth and maturation of this skeletal system far outstrips that of the former. We know, or think we know, quite a little about its origins, embryology, rate and time of growth, and even its sex differences. Of the gut structures we know little beyond their origins and embryological development. Let us examine critically those few things we do know.

First of all it should be recalled that the teeth are laid down before any jaw bones are present (*Fig.* 6). Following the establishment of a common stomodeum, i.e., before its separation into nose and mouth, the epithelium of its lining invades the surrounding mesenchyme. As the middle cells of this layer break down the two jaw parts, upper and lower, are separated for the first time. The epithelium, which now covers them, proliferates along their crests to give rise to the dental lamina. At ten points along the lamina, localized proliferations occur indicative of the formation of the primary teeth. Proceeding further, the epithelium separates the jaw from the cheek portion to form the vestibule.

Looking at a frontal section at this stage one can see how far the tooth buds have developed before bone has appeared (*Fig.* 7). Eventually, from the lower lingual aspect of Meckel's carti-

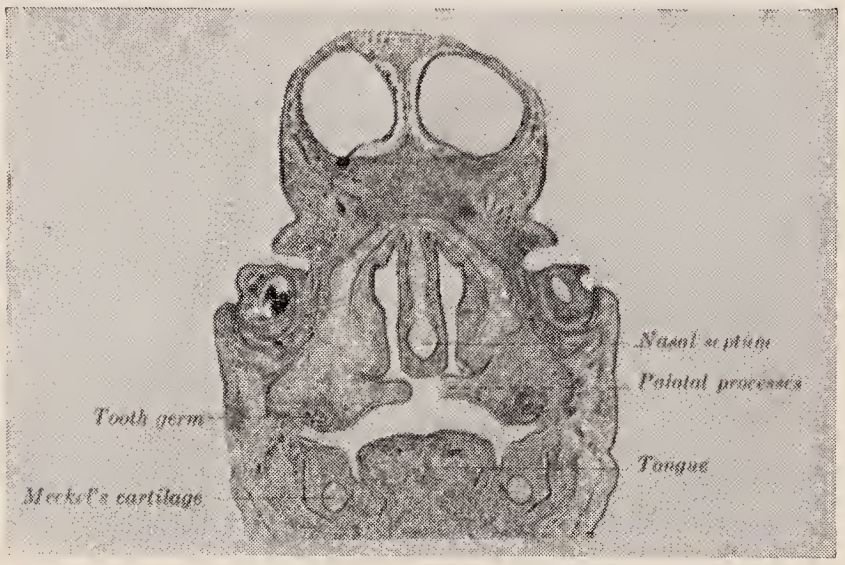

Fig. 6.—Frontal section of head of 27-mm. human embryo. (*From Schour, Noyes' Oral Histology and Embryology, Philadelphia: Lea & Febiger.*)

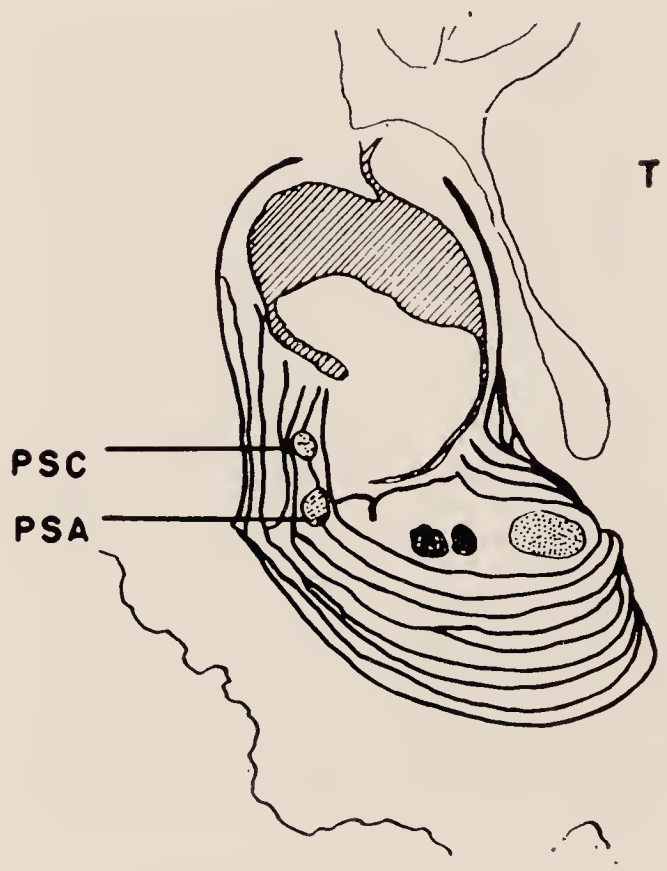

Fig. 7.—Camera lucida drawing of frontal section through first molar region of rat embryo. (*From Bhaskar, S. N.* (1953), *Amer. J. Anat.*, **92,** 1.)

lage, a sheathing of bone appears, and, curving upward on both sides of the cartilage, rises to the level of the tooth germ and passes beyond, but does not close over it. This was demonstrated by Bhaskar (1953) on rats of the I.A. strain. Now let us look at the developmental stages of the teeth themselves.

In 1960 Hoffman reported on the behaviour of tooth germ transplants placed in connective tissue of host animals (*Fig.* 8). The transplants were at the stage of formation of the dento-enamel junction. They proceeded to complete their crown formation and to establish the

Fig. 8.—Stage of development of hamster molar at time of implantation into peritoneal cavity. (*Figs.* 8–10 *from Hoffman, R. L.* (1960), *J. dent. Res.*, **39,** 781.)

Fig. 10.—Formation of bone at distal ends of periodontal fibres.

epithelial sheath of Hertwig (*Fig.* 9). Following this the roots began to form, and as they did so connective tissue derived from the mesenchyme surrounding them oriented itself in a manner similar to that of the periodontal ligament (*Fig.* 10). In turn, the formation of bone was induced around and between the roots. This was evidence enough, for us at least, that the teeth, periodontal ligament, and alveolar bone were derived from one system—that of the gut—while the jaws were derived from another—the skeletal.

At birth, those parts of the maxilla and mandible that will eventually carry the teeth consist of nothing more than troughs. Open on their mouth sides they contain the partially calcified crowns

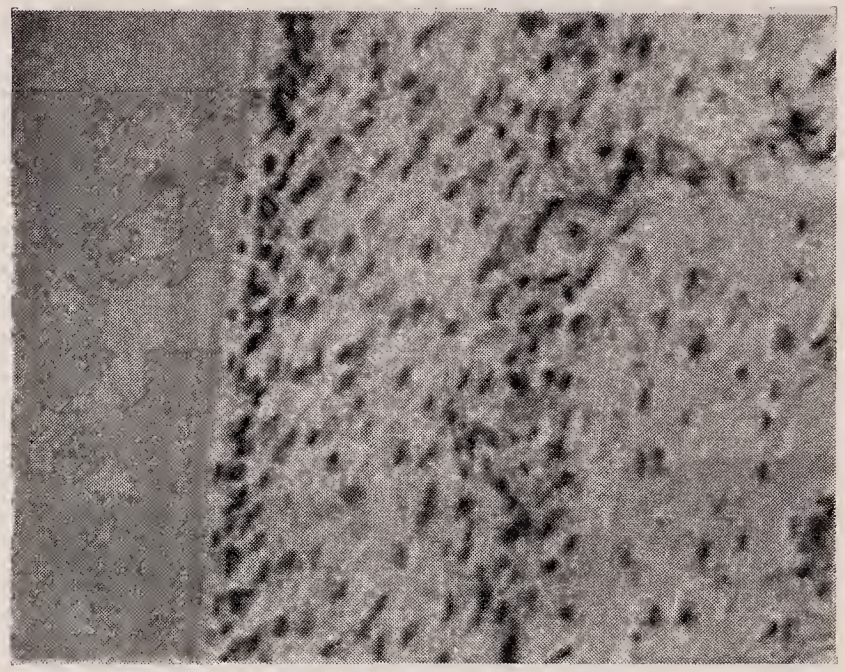

Fig. 9.—Orientation of mesenchymal tissue around forming roots of implant.

of the primary teeth which are separated from each other by transverse partitions (*Fig.* 11). Henceforth, until they erupt their positions will be mainly under the control of the jaws as those structures grow.

If one examines a frontal laminagram of the head of a newborn (*Fig* 12) it is seen that the tongue largely fills the mouth cavity and may even flow out between the pads covering the two jaws. The cheeks and the fat pads outside are frequently in contact with the periphery of the tongue. As the teeth erupt they separate these two muscle masses for the first time, and it requires little imagination to realize that their bucco- and labiolingual inclinations as well as that of their alveolar processes would be dictated by these contending muscle forces. By this time the muscle sheath has attained most of its width.

In order to understand why crowding becomes apparent with the onset of the mixed dentition it is necessary to take into account several factors in addition to the differences in the size of the teeth of the two sets. This is usually the only cause mentioned.

The jaws, like all other parts of the skeletal system, increase in size gradually, proceeding from stage to stage by imperceptible degrees as temperature rises in a thermometer. This is called a continuous variable. It is a variable in that this growth, although it may be steady, occurs at different rates and therefore covers different periods of the growth span in different individuals. Thus one may grow rapidly, i.e., at a high rate, during early life only to slow abruptly,

well before the average of his age peers, while another may grow more slowly, but stretch that growth over a much longer period of time.

The teeth and their alveolar processes are a matter of an entirely different sort. Attaining the full size of their crowns deep in the jaws they exhibit wide ranges of variation in their order, time, and rate of eruption. They represent a discontinuous variable in that the entire crown must be accommodated at one time and this within an arch, the dimensions of which are largely determined by the musculature of its environment. Thus synchrony, or lack of synchrony, between these two sets of variables is probably an equally significant determinant of whether the stage of the mixed dentition exhibits spacing, crowding, or normal arrangement of the teeth.

The area of attachment of the buccinator muscle, the chief constricting agent acting on the dentition, might be said to follow the periphery of the apical bases of the maxilla and mandible. The disposition of this muscle would therefore be influenced by the size, form, and relation of these bases, as well as by those variables of its own growth and maturation, such as its stage of development, its degree of tension, etc. Thus far we have been unable to measure these muscle variables, but we have finally developed a technique to measure its area of attachment, viz., the apical base, and study its age changes, at least in the maxilla.

Our lead for this approach was derived from the demonstration by Downs in 1944, that it was possible to delineate both the dental arch and what we assumed to be the maxillary apical base by X-raying the upper plaster model from above with the teeth resting on an occlusal film.

It occurred to us that a similar view could be obtained from an occlusal film of the living by positioning the X-ray tube above and in front of the head with the axis ray directed at right-angles to the film. This study was undertaken by Richardson (Richardson and Brodie, 1964). A pilot study conducted on 25 individuals from 3 to 27 years of age showed that these X-rays were comparable to X-rays of the models of the same individuals with very small error. The

Fig. 11.—Jaws of newborn infant. (*From Hunter, J.* (1771), *Natural History of the Human Teeth.*)

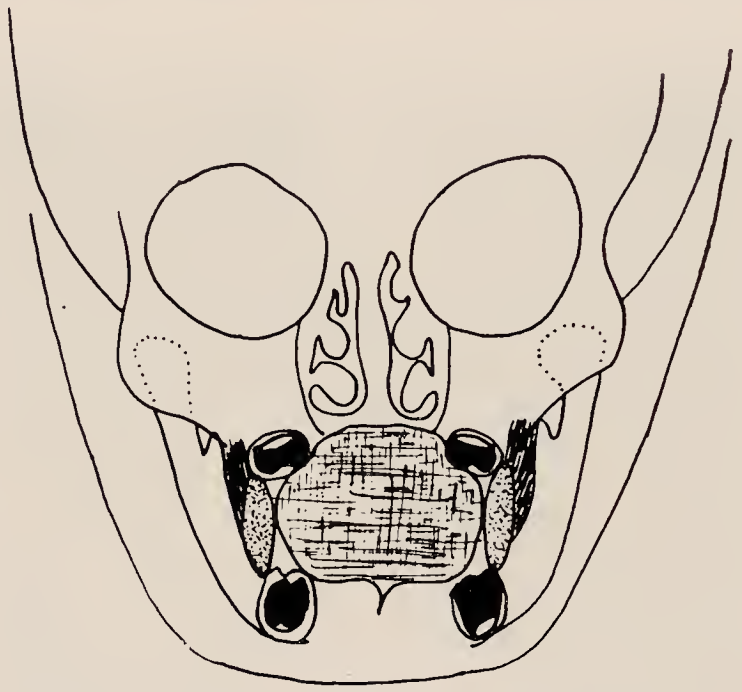

Fig. 12.—Tracing of frontal laminagram of newborn infant.

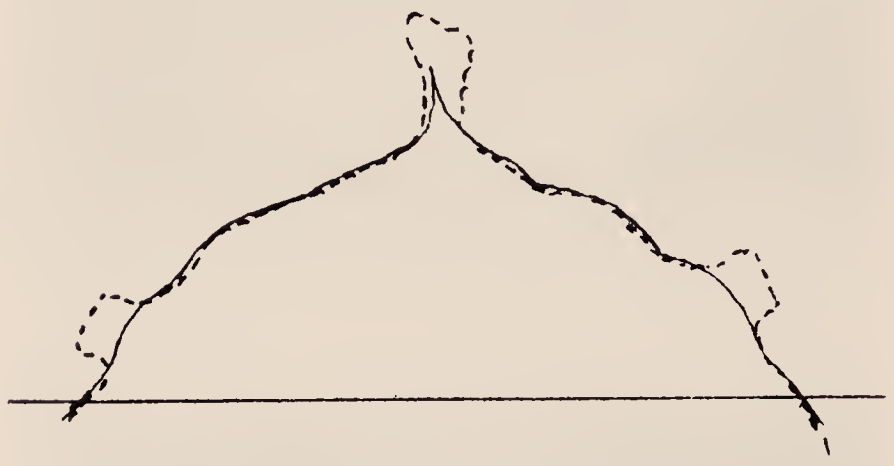

Fig. 13.—Tracing of an X-ray of the apical base anterior to the maxillary permanent molar superimposed over the circumscribed area of the trimmed model of the same individual.

method was next tested on a series of models taken on children at 8 years and again at 16 years of age (*Fig.* 13). This revealed that it was possible to obtain an accurate outline of the apical base from the plaster model without recourse to X-rays. The way was now open for longitudinal studies of width and area growth. The area of

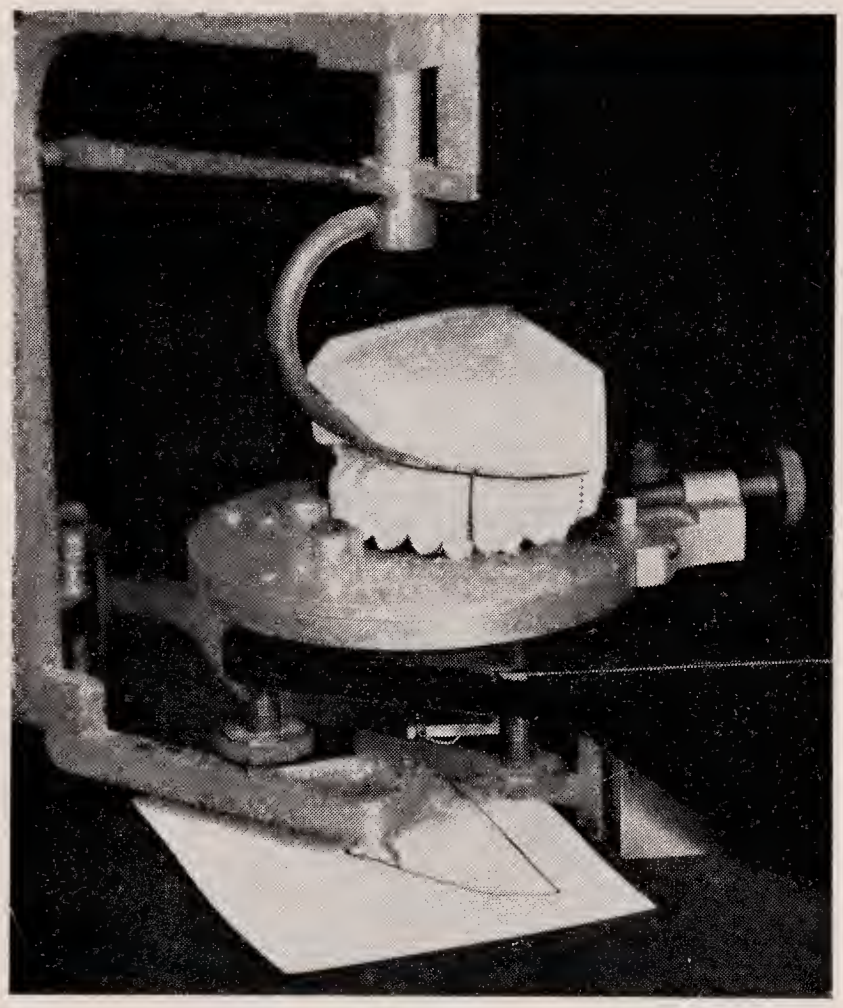

Fig. 14.—Technique of scribing apical base. Level of base is derived from lateral cephalometric X-ray.

Fig. 16.—Periphery of dental arch area. In the study the outline was drawn on the occlusal X-ray film.

the apical base can be measured in square millimeters with a planimeter, and its form and dimensions studied simultaneously.

Briefly the technique, (*Fig.* 14) is as follows: The model is placed, teeth down, on a platform equipped with a pantograph modified so as to allow a pencil marker to follow the course of an anthropometric needle on a sheet of paper lying below the platform. The point of the needle is set at the level of the apex of the root of the central incisor. This distance is derived from the lateral cephalometric X-ray by dropping a

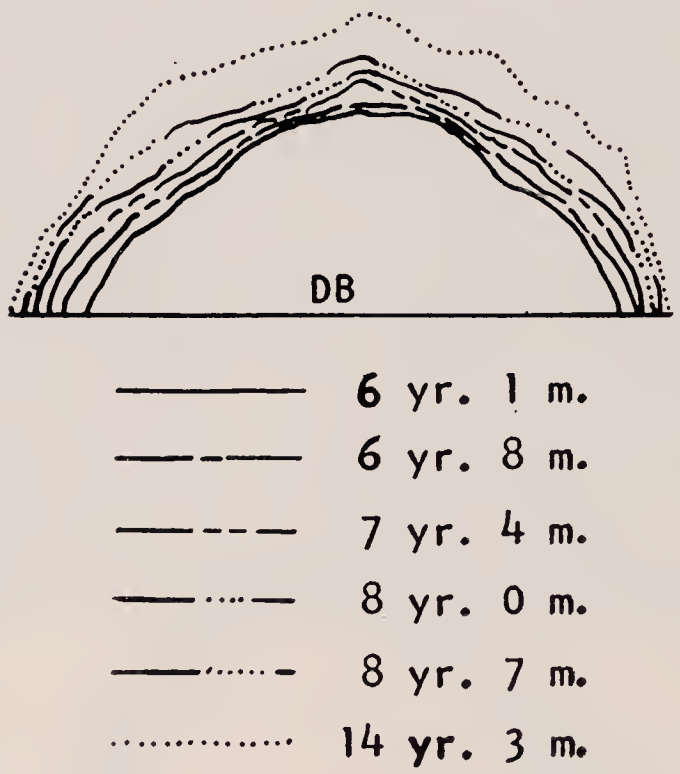

Fig. 15.—Superimposed serial outlines of apical base at different ages.

perpendicular from the root apex of the central incisor to a line representing the occlusal plane. This distance is maintained as a constant for all models of the individual.

Growth curves (*Fig.* 15) constructed from the planimetric readings have revealed a behaviour pattern typical of other parts of the head skeleton, i.e., it is characterized by a steady increase on diminishing gradients. Furthermore, this increase is accompanied by changes in its form. It becomes shorter and its anterior portion becomes wider.

In the early stages of these studies only that portion of the apical base which supports the deciduous dentition and later the succedaneous teeth was measured. A posterior limit was set by drawing a transverse line connecting the interproximal contact points between the second primary and first permanent molars. The purpose of limiting our first studies to this area was to permit an evaluation of John Hunter's postulate of 1771 when he stated:—

> The jaw still increases in all points till twelve months after birth, when the bodies of all the six teeth are pretty well formed; but it never after increases in length between the symphass and the sixth tooth; and from this time too, the alveolar process, which makes the anterior part of the arches of both jaws, never becomes a section of a larger circle, whence the lower part of a child's face is flatter, or not so projecting forwards as in the adult.

The greatest area of the tooth arch was measured beginning at the same line, by connecting a series of straight lines between the most prominent points on each of the teeth (*Fig.* 16). This simulated the course that would be followed by an elastic band under tension.

In *Fig.* 17, graph No. 1 reveals the growth curves of the mean measurements of the area of the apical base and of the tooth arch in the total sample of 88 boys and girls from 6 to 17 years of life. It will be noted that the two curves start at almost the same size although the apical base is about 20 sq. mm. smaller in this sample

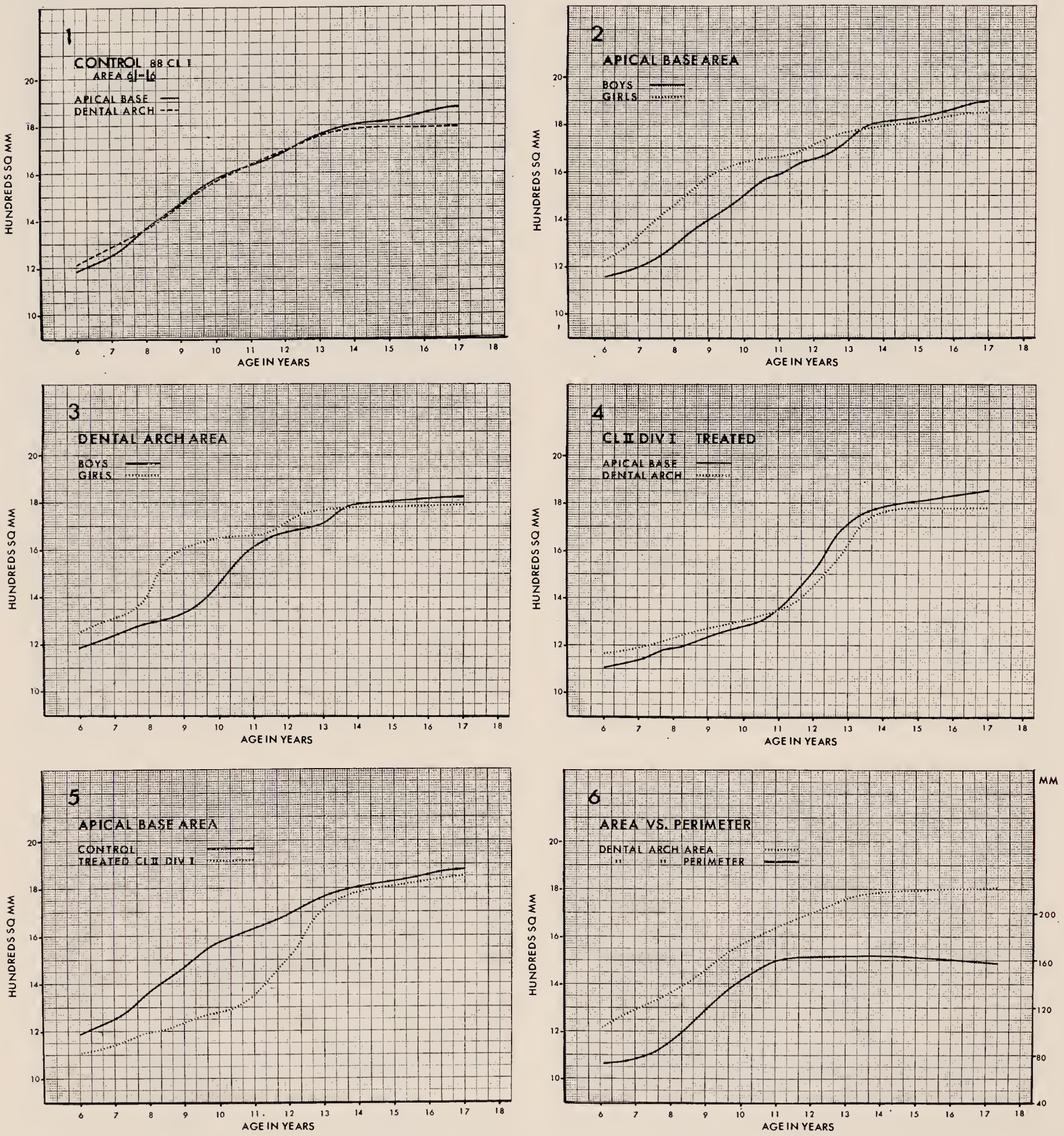

Fig. 17.—Graphs derived from raw data of the investigation. (1) Areas in sq. mm. of the apical base and of the dental arch from 6 yr. to 17 yr. in a mixed sample of 88 individuals. (2) Sex differences in growth of apical base area. (3) Sex differences in growth of dental arch area. (4) Areas of apical base and of dental arch in a mixed sample of Class II, division 1 malocclusions treated beginning at the tenth to eleventh year. (5) Comparison between curves of development of apical base in treated and control samples. (6) Comparison of curves of area development and perimeter length of control sample.

at the 6-year level. From $8\frac{1}{2}$ to 13 years the curves remain almost identical, but then they break apart, the apical base continuing to increase at only a slightly diminishing rate while the curve of the tooth arch area flattens until there is 80 sq. mm. separating them at 17 years. However, it should be noted that the area of the dental arch continues to increase, albeit very slowly.

Fig. 17, graph No 2 shows the sex differences in the increase in apical base area. It will be noted that it is larger in girls than in boys at 6 years, but that the boys pass the girls between 13 and 14 and continue to gain on them to at least the seventeenth year.

Fig. 17, graph No. 3 indicates the sex difference in the area of the dental arch. Girls exhibit a marked acceleration beginning at 8 years, which slows between 9 and 10 while boys exhibit their most rapid gain beginning between 9 and 10 and continuing until between 13 and 14 years. There is little difference between them at 17 years, that of the boys being only 20 sq. mm. larger.

The application of these techniques to a group of Class II, division 1 cases yielded results that were even more unexpected, as will be seen in *Fig.* 17, graph No. 4.

This graph sets forth the findings on a sample of 48 Class II, division 1 malocclusions treated in our clinic. All cases were equipped with bands on the upper first permanent molars to which facebows and cervical straps were applied until a full Class I molar relation was established. The marked changes in the areas of the apical base and the dental arch during treatment shown by these curves accompanied the change in jaw relations and seem to have resulted from it since no mechanical forces were allowed to operate on any teeth save the upper first permanent molars.

But a change in jaw relation influences more than just the bones that are involved. Howland (1963) demonstrated by means of strain gauges that each of the three major classes of malocclusion has its own rather characteristic pattern of buccinator pressures. The peaked arch of the Class II, division 1 case is associated with buccinator pressures in the maxillary dental and alveolar area that are noticeably higher than in the other two classes. *Fig.* 17, graph No. 5 compares the curve of development of the area of the apical bases in the sample of 88 children who required no treatment with those treated for Class II, division 1 malocclusion. The curves of the dental arch areas of the treated and untreated samples show similar differences.

These curves at 6 years of age reveal a difference in their areas of only 80 sq. mm., but thereafter they behave in distinctly different manners. The curve representing the control group indicates the behaviour of typical, facial-skeletal growth. That of the Class II, division 1 malocclusions exhibit increasing separation from or lag behind those of the control.

Beginning with the institution of treatment between 10 and 11 years on the average, the curves of the Class II, division 1 sample rise steeply until they almost reach the level of the control group, by the seventeenth year they are identical to all intents and purposes. The potentials of the two groups seem to have been the same.

The skeleton exhibits a steady increase and maturation postnatally until adulthood subject only to the individual variations of its gradients. The apices of the teeth follow this growth. The gut system from which the teeth, alveolar processes, and stomodeal musculature are derived grow rapidly during prenatal and early postnatal life and then slow to almost a standstill by late childhood. The crowns of the teeth are controlled by this system. The two systems are joined only at the junction of the true jaws and the musculature which encloses the teeth and alveolar processes, viz., at the apical bases.

By the time we had reached this stage of our studies certain seeming contradictions were obtruding themselves. The chief of these was the slow but continuous increase in the dental arch area after all of the succedaneous teeth had taken their places. This did not fit with the well-known fact that the size of tooth crowns does not increase. The combined mesiodistal diameters of the teeth had been measured by many workers, with the invariable finding that if any change was evident it would be a shortening. We finally realized that we had been trying to equate linear dimensions with areas. A mathematician could possibly have solved our dilemma, but, alas, we were not mathematicians so we had to do it the hard way. We measured the lengths of the perimeters. Employing a map measure, an instrument that permits the determination of the length of irregular lines, we plotted the lengths of the peripheries against the sq. mm. of areas contained within them (*Fig.* 17, graph No. 6).

This graph requires a word of explanation because of the scales on the two sides. The figures on the left side give the area in hundreds of sq. mm. contained within the perimeter, solid line, the length of which is expressed in mm. shown on the scale to the right. The two curves are shown together here merely to convey some idea of how an alteration in the shape of a perimeter can alter the size of the area it encloses.

The solid line represents the mean curve of the length of the perimeter of the dental arch area in mm. of the same sample of cases whose dental arch areas had already been derived. The differences between them are clearly apparent. It will be seen that the line representing the perimeter shows a very slow rise between 6 and 8 years, probably attributable to earlier eruption of the central incisors or developmental spacing in a portion of the sample. Beginning at 8 years there

is a rapid rise until beyond 10 years, which covers the period of the replacement of most of the primary incisors and canines by their permanent successors. Following this there is an decline probably results from the replacement of the primary molars in some of the cases by premolars that are smaller than their predecessors.

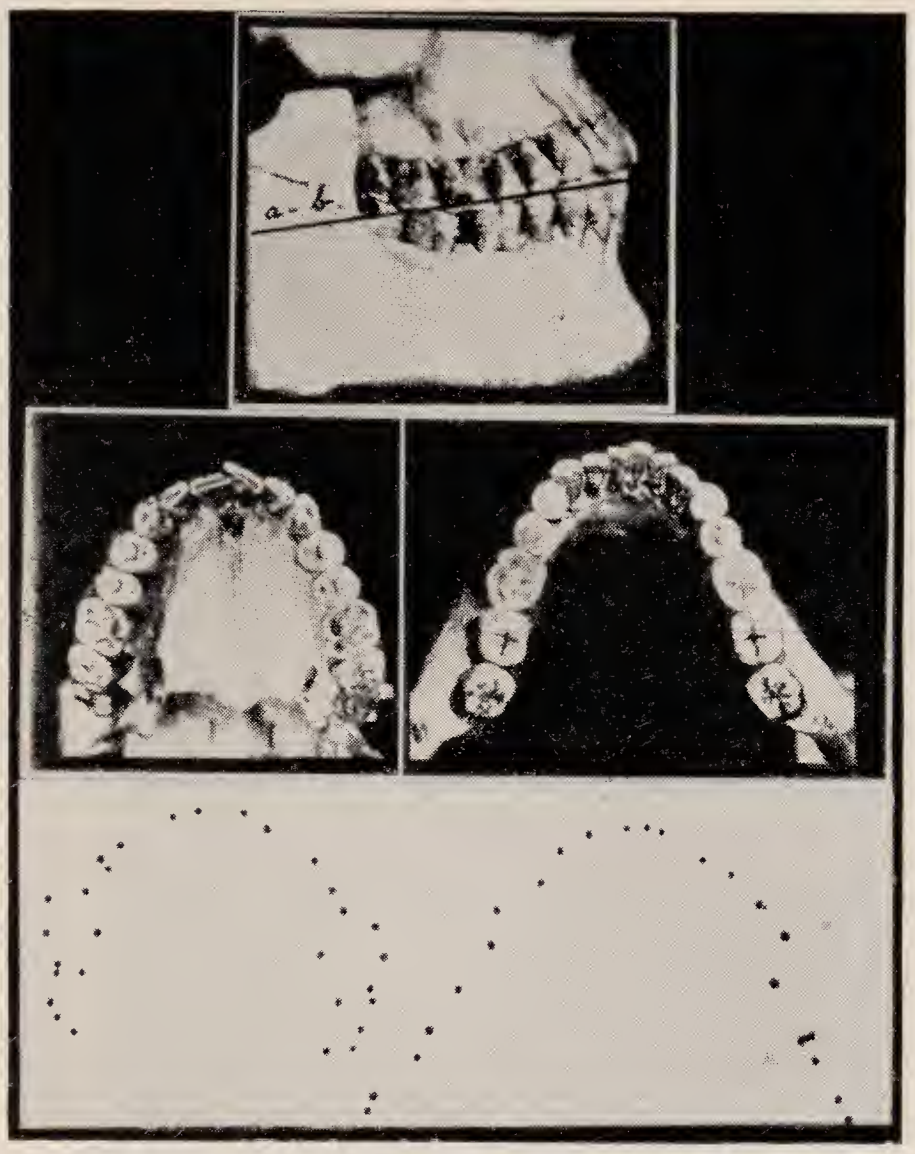

Fig. 18.—Note difference between the disposition of the apices of the maxillary and mandibular teeth. (*Reproduced with permission from monograph by Lundström, A.* (1923), *Svensk tandläk. Tidskr.*)

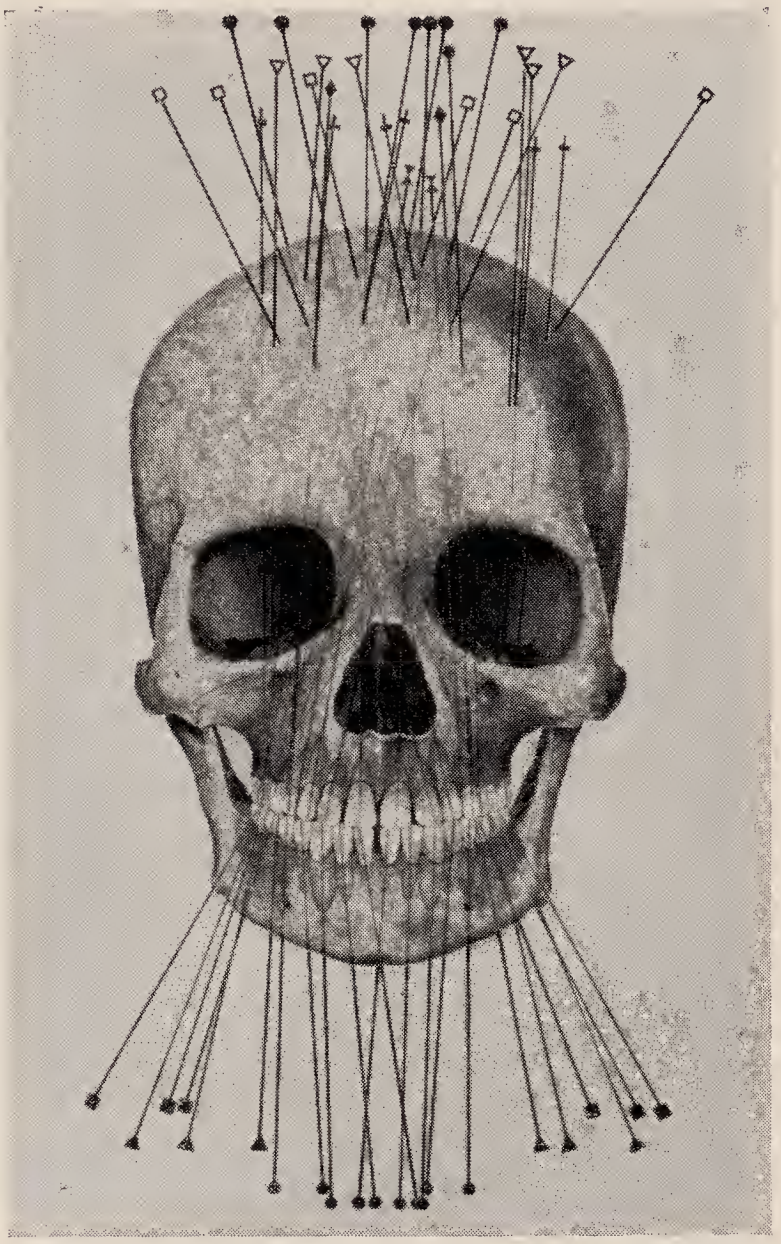

Fig. 19.—The axial inclinations of human teeth as shown by wires. (*Figs.* 19 *and* 20 *from Dempster, W. T., Adams, W. J., and Duddles, R. A.* (1963), *J. Amer. dent. Ass.*, **67**, 779.)

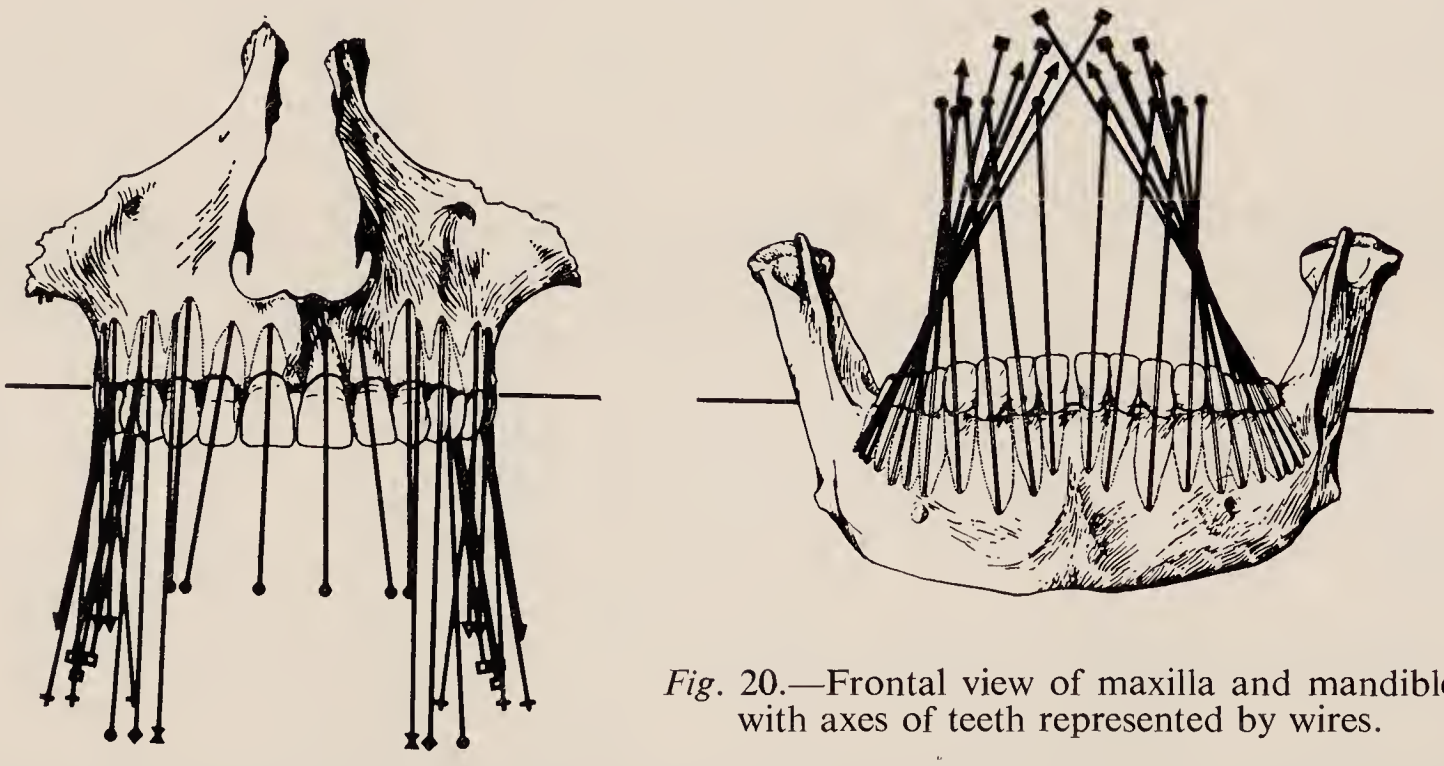

Fig. 20.—Frontal view of maxilla and mandible with axes of teeth represented by wires.

abrupt flattening of the curve to age 12 or 13 years. Thereafter the curve drops slowly, indicating a shortening of the periphery. This

From these curves it becomes apparent why it has never been possible to find correlations between dental and facial dimensions although

the effort has been made repeatedly. Much confusion in the diagnosis of malocclusion has been occasioned by the failure to recognize that the state of the dentition at any given time is the result of the interactions between two distinctly different systems—skeleton and gut. It would appear that we have not paid sufficient attention heretofore to area measurements. Our concern

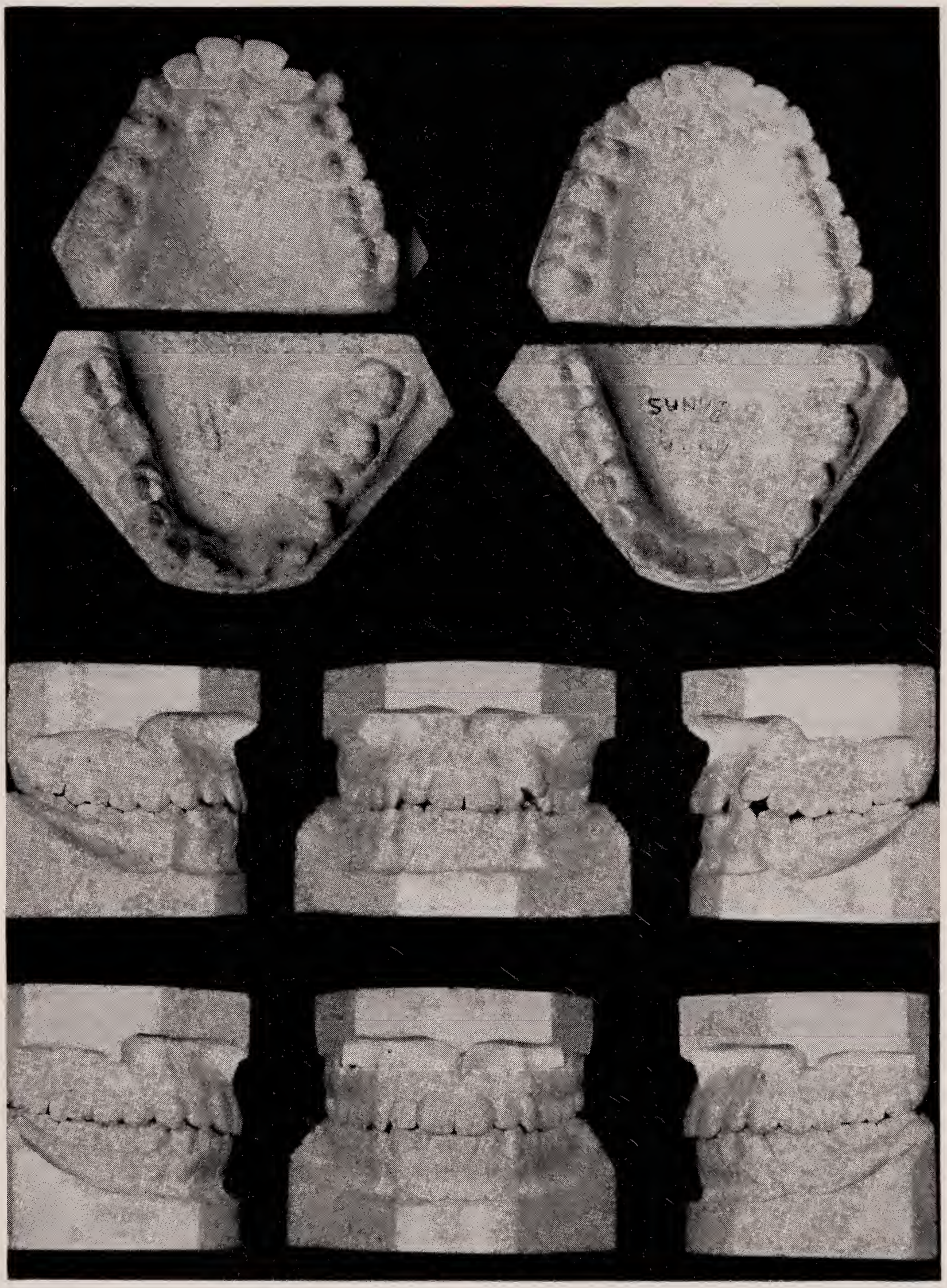

Fig. 21.—Case presenting severe lack of arch length in female of 14 years. Models show case before and 2 years after removal of retention.

has been solely with arch length problems to the complete neglect of the effects on the areas enclosed by such arch lengths. We have not realized the great alterations in areas that accompany changes in form.

To date we have not been able to apply the same methods to the determination of the mandibular apical base that have proved fruitful in the maxilla. However, two earlier pieces of work have indicated that the same two diverse influences are at work on the dental and skeletal parts of this bone. The first of these appeared as an illustration in Lundström's monograph in 1923 (*Fig.* 18). He did not describe the method used to locate the apices of the mandibular teeth, but that this was done on a plane parallel to the occlusal plane seems apparent from the illustration. At the bottom of the illustration may be seen the different courses taken by the molar series of the two jaws; the maxillary roots being positioned medially toward the posterior of the arch and the mandibular diverging laterally on straight lines.

A study directed at entirely different questions, but offering strong supporting evidence for the concept under discussion, was described by Dempster, Adams, and Duddles (1963). They drilled holes representing the axes of all of the roots of the teeth of thirteen adult skulls with normal occlusion and continued them through to the exterior of their skeletal support. They then placed thin, stiff wires in the holes and studied their inclinations (*Fig.* 19).

It will be noted that the wires running through the mandibular teeth all emerge at or very close to the mandibular border (*Fig.* 20). We interpret this as indicating that the apices of the roots travel with the outer bone covering them as the mandible grows. This is likewise evident in the maxilla. Any collection of dried skulls will disclose a number in which the apices of the maxillary canines and first molars are exposed on the outer surface.

The behaviour of the molars offers even better evidence if one recalls the course of the buccinator as it travels from the outer to the inner aspect of maxilla and mandible. At the maxillary level the peripheries of the dental arch and of the apical base tend to follow each other although the apical base in the molar region seems more constricted than does the tooth arch. This difference is reflected in the increasing buccal inclination of the teeth from the first to the third molar. The evidence of the different influences operating on the crowns and on the root apices is shown even more strikingly in the mandible.

Thus far we have been considering the course of events as these occur in the normally growing individual. But the orthodontist is concerned with those conditions that face him in treatment. Let us consider them briefly.

The lack of arch length in the developing dentition has always been a troublesome problem, but it has probably not been viewed in its true light. There has been a strong tendency to consider it a result of the movement of teeth in mesiodistal directions and there has been much talk of mesial drift in the ' trough ' of the mandible.

Actually, the apices of the teeth move very little from the sites of their origins; indeed, we all

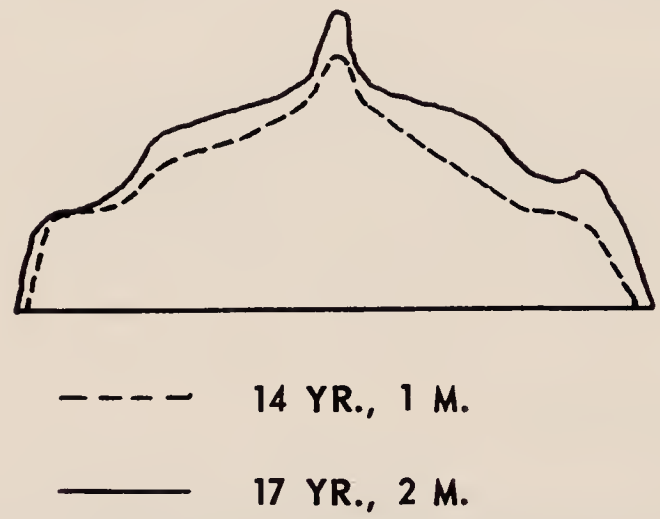

Fig. 22.—Apical base before treatment and two years after removal of retention.

know how difficult it is to move them even with powerful forces. Nearly all movements of teeth in response to lack of arch length are tipping movements of exactly the nature to be expected from a constricting force working from without—the very kind of a force that is generated by the lips and cheeks.

If now we add the complicating factor of a slowness in the development of the apical bases of the maxilla, mandible, or both, or a precocity of eruption, it can be understood why the treatment of such cases by the usual arch lengthening or expansion methods has led to frequent disappointment. Under such circumstances we are faced with opposition of both influences—skeletal *and* muscular—because the effectiveness of the offending musculature is largely determined by the size of the same area that controls the root ends. Growth of this area tends to correct both influences simultaneously. But growth demands time (*Fig.* 21).

In the case illustrated we have what I believe you will agree was a severe case of lack of arch length. Furthermore, it was a female at an age when growth is supposed to be complete. The prognosis was poor for non-extraction treatment, but the patient would not agree to the removal of teeth. The final result, two years after the removal of the retainers, gives no indication of the original condition and the tracings of the before-and-after apical bases reveal the probable explanation for the result (*Fig.* 22).

Now I should not wish to leave you with the idea that I am recommending a return to non-extraction treatment. I do wish to emphasize the

fact that it is more frequently possible than it is generally held to be. More children grow than do not grow, but they do not all grow in the amount or at the times that the statistical tables indicate. Each child is an individual and in no characteristic does he or she reveal that individuality more clearly than in the pattern of growth. The apical base—the zone of interaction between the skeletal and the digestive systems —is an integral and important part of this pattern.

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DISCUSSION

Professor C. F. Ballard, opening the discussion, wished to thank Professor Brodie personally for the very important contributions that he had made to orthodontics. Next to Professor Brodie's own contributions were the very important contributions that his graduates had also made.

Dr. J. R. E. Mills said that Professor Brodie's figures were presumably averages. Did most cases behave like the average, or did he find much individual variation?

Professor Brodie, in reply, said that one of the first things he intended to look at was the individual and determine what the range of individual variation was.

Mr. A. J. Walpole Day referred to the girl who went on growing after one might have expected growth to stop, and said there was another possible explanation of the end result, namely if all the third molars had been missing.

Professor Brodie said he could not remember whether the third molars were present or not.

Mr. P. H. Burke remarked that Greulich in his work on general growth had related curves of general growth to physiology, particularly in girls, and that had provided information about the variation in rates of growth. Had Professor Brodie been able to do the same with rates of growth in respect of dental bases?

Professor Brodie said he had not gone that far, but he was using the same data in a number of other different types of work. For instance, work had recently been published on the closure of the spheno-occipital junction, which was said to close at between 18 to 25, but he had found it completely obliterated at the age of 8 years in a female.

Mr. P. H. Burke asked what method Professor Brodie was using for measuring the areas.

Professor Brodie said that after he had delineated the area, it was measured with a planimeter and expressed in square millimetres.

Mr. B. S. Cryer asked the lecturer whether he would comment on two statements which appear in textbooks. Firstly, that a child can inherit the size of jaws from one parent and the size of teeth from the other. Secondly, that the reduction in the length of the jaws as an evolutionary trend and the reduction of the dentition are not entirely correlated.

Professor Brodie, in reply, said he could not subscribe to this. It had recently been pointed out to him by Krogman that although teeth had long been considered the least subject to phylogenetic change this might not be so. A large supernumerary cusp exhibited by the youngest member of a family line can frequently be traced to an initial, small cusp in a grandparent. Such a profound change in such a short span of time had never been demonstrated in any other organ, particularly one of such great survival value as a tooth.

As far as the reduction in the number of teeth was concerned there seemed to be increasing scepticism on this point also. Although there was agreement that there had been a reduction of two premolars and one incisor in the Mammalia there had been no further reduction from the early apes to man.

As to the first part of the question, evidence could be found to support the point, but it was difficult to think of any two parts of the body with which one could not do exactly the same thing.

Mr. W. A. B. Brown asked Professor Brodie if he had considered using metallic implants to resolve some of the problems of the apical base.

Professor Brodie said that a factor which made them valueless for the type of work under discussion was the very stability of the implant. He was engaged in some implant work on pigs two or three years ago, in which bilateral implants were made in the nasal bone, in the frontal bones, in the maxillae, the zygomas, and others were placed in the zygomatic processes of the temporal bones which constitute the posterior half of the zygomatic arch. The animal was allowed to grow and X-rays were taken. The teaching had been that the zygomatic arch travelled laterally with growth by deposition on the outside and absorption on the inside. That was found to be true of the zygomatic processes of the temporal, but the zygomatic bones travelled laterally by lateral growth of the maxillae. This finding was subsequently made on the rabbit and on the Rhesus monkey.

Mr. T. Freer asked if animal experiments could be extrapolated to human beings with any validity.

Professor Brodie replied qualitatively, yes, but quantitatively, no. One can arrive at quantitative

conclusions only from the particular animal species being studied.

Dr. G. B. Hopkin said he was at the present time trying to get some information on the growth of the tongue. Preliminary results on a small sample suggested that between the neonatal period and the adult the tongue appeared to double all its dimensions, that is, length, breadth, and width.

Professor R. B. Dockrell said there was a double graph where on one side there was the perimeter measurement and on the other the area measurement. It would be interesting to know what determined the two scales as two very different lines could have resulted merely by altering the scales.

Also, in an experiment that he had carried out a number of years before, he had attempted to make perimeter measurements on plastic models, but had been unable to measure satisfactorily owing to the presence of muscle insertions and the lack of a reliable base line from which to measure. He would be glad if Professor Brodie could tell him how he had overcome these difficulties. He would also like to know why Professor Brodie had used a point at the apices of the teeth rather than one above them and as such presumably less susceptible to 'oral' influences.

Professor Brodie, in reply, said it was done in that way to show the difference in the form of the curve, and the scale was not important in that context. It was a correction of the first slide showing the graph where the dental arch and the apical base followed each other, and then there was a little separation indicating that the dental arch was increasing; but it was known that that was not so.

Professor Dockrell said he had endeavoured to carry out a measurement of a similar perimeter by the measuring of models with a mapping device, and it seemed advisable to measure above the apices of the teeth as well as at them.

Professor Brodie said that in the pilot study there were twenty-five infants at various ages, and models and X-rays were taken. Then the models were cut at the proper level. It was found when that was done that the error was so small that it was insignificant. The deciduous dentition yielded a larger area, due to the thicker soft-tissue covering as compared to that of the adult stage.

Mr. G. H. Steel said it might well be agreed that A and B points changed during orthodontic treatment. It would be interesting to hear whether Professor Brodie felt that there was any variation of the apical base line following orthodontically treated cases.

Professor Brodie said that work had already commenced on the difference in the behaviour of the apical base with orthodontic treatment. He did not expect to see any great quantitative change.

Some of that variation of the A point might arise through the actual height of the labial alveolar area.

Mr. H. Lester recalled that Professor Brodie showed a case which had been treated by appliances and subsequently remained stable for two years. It would be interesting to know whether he had speculated on how much the growth potential which was present in that case would have affected the malocclusion had it remained untreated.

Professor Brodie said that he had considered it, not so much in connexion with the particular case; but he had seen bad malocclusions improve with growth, even up to around 18 and 19 years of age. Unfortunately, they did not usually improve as far as lapped contacts and individual tooth positions were concerned.

The President expressed gratitude to Professor Brodie for coming all the way from the United States specially to present this lecture. The size of the audience must have given Professor Brodie some idea of the regard in which he was held.

SURGICAL PROBLEMS OF ORTHODONTIC INTEREST

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THERE is no branch of oral surgery which is not of considerable interest to the orthodontist. It is conceivable that one could practise as an orthodontist without a wide knowledge of oral surgery, but an intelligent appreciation of oral surgical problems is impossible without a knowledge of orthodontic principles. It is interesting that today a trainee orthodontist must satisfy the examiners for the Surgical Dental Fellowship, but that a trainee in oral surgery may never acquire more than his undergraduate orthodontic experience.

I trust that this paper will make it abundantly clear that at least one oral surgeon would benefit from a more advanced orthodontic training.

Orthodontists are slowly extending their field to cover dental paediatrics, oral surgery in the young, dental medicine, and no doubt ere long, the treatment of cleft palates and the surgical correction of jaw deformities. This paper may, therefore, be of practical use to a number of you. I have chosen to discuss the following subjects: Temporomandibular joint disturbances; Unerupted upper canine teeth; Jaw deformities and associated orthodontic abnormalities; Fractures of the mandibular condyle neck in children.

TEMPOROMANDIBULAR JOINT DISTURBANCES

These can be classified into nine groups, but we need only concern ourselves with four of these which have orthodontic connexions; for the sake of completion I will list the others:—

Group 1: Osteoarthritis.

Group 2: Rheumatoid arthritis.

Group 3: Patients who have lost dental support on one side of the jaw following dental extractions.

These patients may complain of a vague ache in and around one or other of the joints. They may complain of a click associated with the joint. They may have mild tinnitus. The important feature is that all of these symptoms are *mild*. The symptoms are usually unilateral and are similar to the bilateral symptoms of Group 4.

Group 4. Patients who have lost all teeth from one or both jaws and are wearing dentures which allow over-closure. The multiplicity of symptoms as described by Costen (1934) are well known.

These Groups (3 and 4) are analogous to a tenosynovitis found around other joints. The symptoms are comparable to those found in the ankle and feet of patients who change the height of their shoe heels or who wear shoes with worn-down heels or insufficient arch support. The importance of this Group from the orthodontist's point of view is that it gives rise to the misconception that all temporomandibular joint arthroses are due to loss of, or change in, the dental support for a joint. It is quite clear, particularly in Group 3, that the onset of symptoms can be related to the loss of teeth and that when they are replaced prosthetically the symptoms disappear. The argument then proceeds—if this is the cause in these cases is it not possible that a minor aberration of the articulation is the cause in many other cases of temporomandibular joint arthroses? I find little in my experience to convince me that there is any truth in this argument. The treatment of patients in Groups 2 and 4 is by prosthetic restoration.

Group 5: Fibrositis in the masseter muscle. This condition was described by Snawdon (1949).

The main feature is pain centred in front of the temporomandibular joint. There is marked trismus limited by pain, deviation of the jaw to the affected side, and very often a history of similar troubles in the neck or back. A tender nodule in the masseter muscle, frequently in its upper anterior quadrant, can be palpated and immediate and complete relief can be obtained by injecting local anaesthetic into the nodule (useful diagnostically). Treatment is by administration of analgesics, massage to the muscle, and local heat as an analgesic.

Group 6: Traumatic arthritis, strained jaw, athlete's (sexual) jaw. This may follow any over-activity of the jaw, over-zealous manipulation during dental extraction, or a particularly lengthy session with the mouth held open in the dental chair or elsewhere—professional (or enthusiastic amateur) singers, elocutionists, swimmers are all liable to this malady. It is found in young people, females very much more frequently than males. The presenting symptom is trismus, limited by

Presented at the meeting held on 14 December, 1964.

pain. A click may be present. A feature of the history is the sudden onset of symptoms, the patient complains of waking in the morning to find that the jaw was locked. This is a well-recognized syndrome, and treatment is based on reassurance, advice, and analgesics, if necessary.

Group 7: The habitual clicking jaw may be found at almost any age, but it is this group which most frequently seeks advice from the orthodontist. This is essentially a clicking jaw with or without trismus and pain. This is in contradistinction to Group 6, where the symptoms were in the reverse order.

It is a common experience to find that when a joint is moved irregularly it can click, and this phenomenon is not peculiar to the temporomandibular joint. The joint's proximity to the ear, however, means that the click is heard, and this unaccustomed noise alarms the patient. The initial click may have been brought on by one short episode of aberrant movement, which may have been quite accidental, but once the patient is aware that a click can be made then it is a natural reaction to attempt to make it a second time and then a third. A subconscious pattern of movement is rapidly built up which makes it almost impossible for the patient to open the jaw without it clicking. If the click persists for weeks or months, pain may become a symptom. In the early stages treatment is simple and effective. It is based on the re-education of the patient in the simple movements of mouth opening. To produce a click the jaw must be opened using one of the joints abnormally. This may take the form of lateral or protrusive movements, or occasionally, forced opening of the mouth by the depressors acting against unrelaxed flexor muscle groups. Smooth relaxed opening of the jaws without protrusive or lateral excursion should be encouraged with opening limited to a point immediately prior to production of the click. The use of a mirror helps in this programme of re-education. In a great proportion of cases minimal bite raising will inhibit the click and the patient is greatly relieved to find that full opening is possible without the accompanying sound effects. The handle of a pair of college tweezers (on the flat) held between the bicuspid teeth will produce the desired effect. The patient is advised to rest the jaw and on no account to make movements which would allow a click to occur. The use of a bite-raising plate simplifies the procedure considerably, but it is very often unnecessary. A bite-raising plate can do two things; it can inhibit the click by making it impossible for the patient to reload the clicking mechanism, and it can be used to rest the temporomandibular joint. The plate does this by limiting the excursion of the condylar head and ensuring that the mandible is held in the ' rest ' position. Bite-raising plates can, therefore, be used to *inhibit* clicks which cannot be got rid of by simple exercise *and*, more usefully, as ' resting splints ' in the treatment of pain associated with these disorders. It must be remembered, however, that it is very much easier to fit a bite-raising appliance than to wean a patient away from one.

Groups 8 and 9: More rare temporomandibular joint disturbances.

To summarize—In the presence of a good complement of natural teeth orthodontic abnormalities do not presage temporomandibular joint disturbances. The natural history of ' fibrositis ', and ' traumatic arthritis ' and ' habitual click ' (i.e., the arthroses) is towards a spontaneous regression. This explains the success of so many varied methods of treatment.

The Problem of the Unerupted Upper Canine

At the outset I would like to say that there is never a 100 per cent answer to this problem, but in very general terms my feeling are these:—

If the canine is unsuitable by virtue of its position for translation by orthodontic means into the available space and the 2–4 space can close naturally, or by orthodontic persuasion, then this should be the aim of treatment. Retained deciduous canines may well be worth considering as a long-term substitute if they do not show root resorption at the age of 13. So often, however, the lateral incisor is rudimentary or may be absent, the retained deciduous canine may be in the process of being resorbed or may be carious, or the first premolar may have been extracted and the unerupted permanent canine may be in a position from which it cannot descend. In these circumstances other forms of treatment are worthy of consideration. Replacement by a partial denture, or bridge, or transplantation of the canine should be considered.

I have been transplanting canines over the past four and a half years. Technically this is not a particularly difficult operation and if the case selection is carefully carried out it is a justifiable procedure. In my series to date, which covers twenty-five teeth, the youngest patient has been 13 and the eldest 27. So far all transplanted teeth have been successful, in that the tooth is still present, and my impression is that they will last certainly for five years and very possibly for ten or even longer. The ten years from the ages of 15 to 25 are probably ten of the longest and most important years of our lives and a fixed tooth is to be preferred to a removable partial denture during these years.

Technique

The unerupted tooth is extracted with minimal trauma, the tooth is then held by the crown with care being taken not to damage the root surface. The tooth is apicectomied and a retrograde root filling, using a Silver point, is inserted. The new socket is prepared using a vulcanite bur and contoured to hold the canine in the correct position.

A prefabricated metal splint is then cemented into position. This is left in position, without interference, for ten consecutive weeks and when removed the tooth should be completely firm in its socket. Follow-up of these cases shows that

Fig. 1.—A, B, Preoperative radiographs of impacted upper canines. C, D, Postoperative views showing transplanted teeth with retrograde root fillings. Previous sockets are clearly shown and the metal splint covers the crowns of the teeth. E, F, Follow-up radiograph taken six months after operation showing good early bone regeneration.

a number develop ankylosis of the tooth root which is clinically diagnosed by percussing the teeth, the ankylosed tooth having a high-pitched, extremely solid note compared with a normal tooth.

Case 1

Miss I. C., aged 22 years (*Figs.* 1, 2), had been wearing a partial upper denture which substituted for both upper canines and the $|\underline{4\ 5}$ for six years. The first premolar had been extracted for orthodontic reasons. The partial denture was satisfactory until the tip of the $\underline{3|}$ began to erupt. This tooth was impacted against the lateral incisor. Both upper canines were transplanted following retrograde root filling and splinted, using a metal splint for a period of ten weeks. Follow-up radiographs taken six months later show consolidation of bone around the roots.

Case 2

Miss W. M., aged 17 years (*Fig.* 3), complained of unsightly carious upper deciduous canines. A very deep overbite made the case unsuitable for a partial denture and difficult for bridges. The permanent

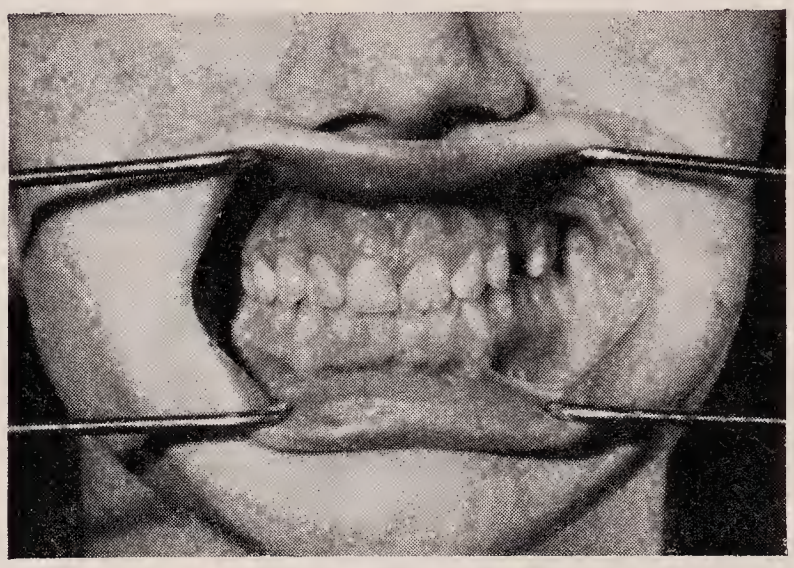

Fig. 2.—The transplanted canines.

Fig. 3.—Pre- and postoperative radiographs of bilateral impacted canines treated by transplantation. The follow-up views were taken $3\frac{1}{2}$ years later.

canines were both palatal and were successfully transplanted. The root fillings in this case utilized gutta-percha points and KRI 2 paste. Follow-up of this case is $3\frac{1}{2}$ years, and both teeth are clinically sound. On the right-hand side there is bony ankylosis, as evidenced by the percussion note, and on the left a normal percussion note.

To summarize—Transplantation of unerupted upper canines is a justifiable procedure where orthodontic correction is impossible and where the construction of a partial denture is undesirable.

Immediate Rotation

Very occasionally a central incisor tooth can be rotated using dental forceps to improve its position and by so doing save a long and complicated orthodontic treatment.

Case 3

Master D. W., aged 7 years (*Fig*. 4), had a congenital cleft lip and palate repaired during infancy. The upper left central incisor tooth had erupted with about 75° rotation and its root was in close proximity to the cleft. Successful orthodontic treatment would have been protracted and the prognosis would have been poor. Immediate rotation, using dental forceps, was carried out, and the tooth splinted for ten weeks.

When the splint was removed the tooth was completely firm and follow-up at a year showed continued root formation; the tooth was of good colour and responded to vitality tests.

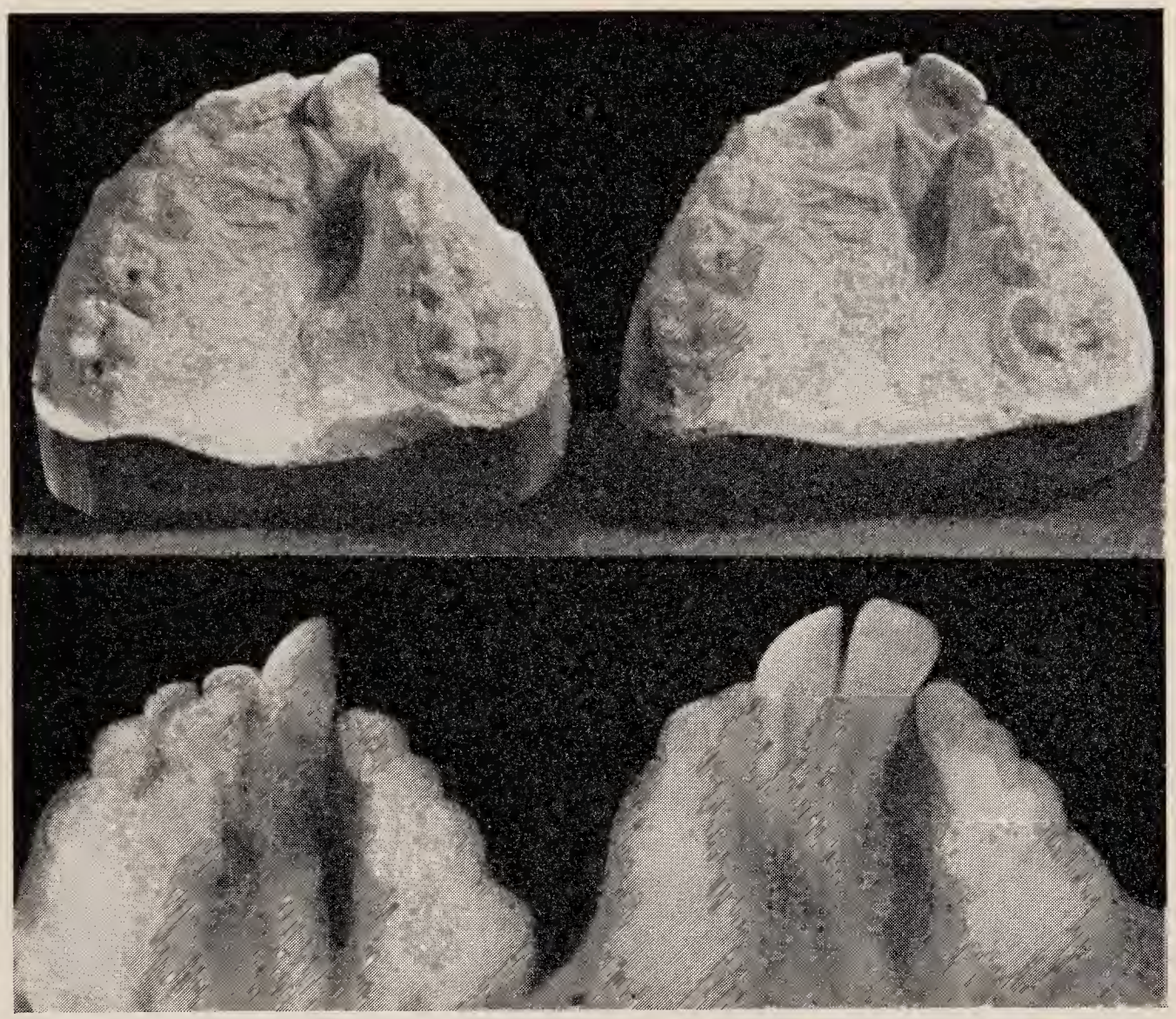

Fig. 4.—Immediate rotation of $\underline{|1}$ by forceps. The follow-up radiograph taken one year later shows good root development of $\underline{|1}$.

SOME OBSERVATIONS OF ORTHODONTIC INTEREST IN PATHOLOGICAL AND SURGICAL CASES

I feel that a great deal can be gleaned from the study of congenital and pathological abnormalities. Much of our knowledge of the growth of the jaws has been learned from a study of the abnormal. The first arch agenesis and the ankylosed jaw in childhood are two excellent examples. Much more, however, could be learned from a closer study of less dramatic cases. For example, what orthodontic abnormalities would we expect to find in a middle-aged lady who had a hen's-egg-sized tumour on the dorsum of the tongue which had been present for twenty-five years (*Fig*. 5). Would we expect orthodontic abnormalities in a boy of 10, who was born with a bilateral facial palsy? (*Fig*. 6).

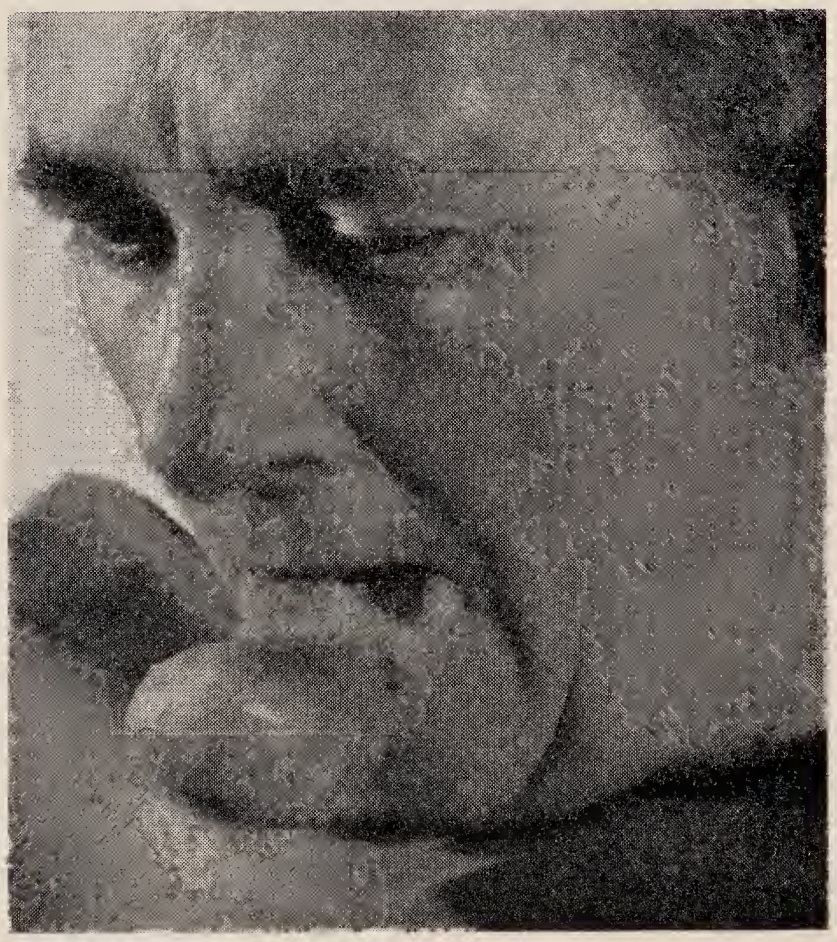

Fig. 5.—A large fibroma of the dorsum of the tongue which, although present for 25 years, failed to cause any marked alteration to the dental arches.

One of the difficulties in studying orthodontics is the problem of being able to establish the difference between fact and theory. For example, theory states that the position of the teeth in the arch is dependent upon the balance between the musculature of the lips and cheeks on one side and the tongue on the other. Is that fact or theory? True or false? My impression is that this is true as it affects the lower arch, but is as yet unproven as it affects the upper arch. In cases of repaired cleft palate, for example, if the tongue were to exert influence on the shape of the upper arch why does it not attempt to maintain the teeth in their correct position, so preventing the collapse of the arch which we so often see (*Figs.* 7, 8).

The affect of the tongue on the shape of the lower arch is beautifully demonstrated in follow-up studies of mandibular prognathism which has been corrected by surgery. In the treatment of mandibular prognathism by surgical reduction of the lower jaw, one of the effects is to confine the tongue in lesser space than it had prior to surgery. It is an established fact that following this type of operation the lower arch expands and the lower incisor teeth become more erect, or in orthodontic parlance, their axial inclination is altered. This fact means, of course, that in planning an osteotomy one must make allowance for these changes. It is interesting to note that although

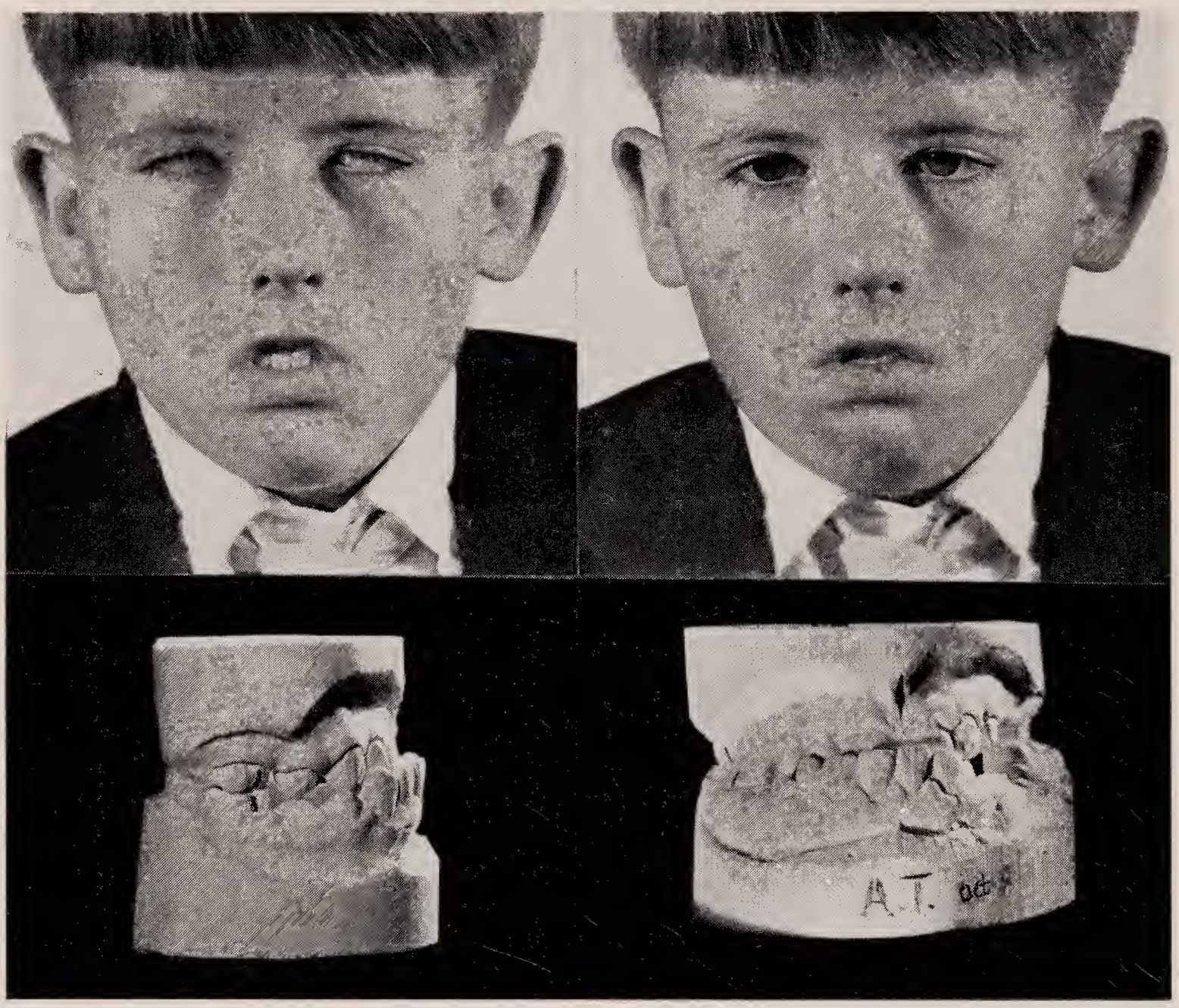

Fig. 6.—Bilateral VIIth nerve palsy. Has the lack of muscular tone in the lower lip been responsible for the development of a Class III bite?

Fig. 7.—Collapsed dental area associated with a cleft lip and alveolus (bilateral) treated by expansion using metal cap splints and elastic traction.

the lower arch is modified by tongue pressure we find no change in the shape of the upper arch.

Case 4 (*Fig*. 9)

An adult male had a gross mandibular prognathism corrected by a body resection in the second and third molar regions. Over 2 cm. of jaw was removed. In twelve months the lower arch in the first molar region expanded 7 mm.

some techniques used for the correction of mandibular prognathism.

FRACTURES OF THE MANDIBULAR CONDYLE IN CHILDREN

The condylar growth centre is responsible for a great deal of downward and forward growth of

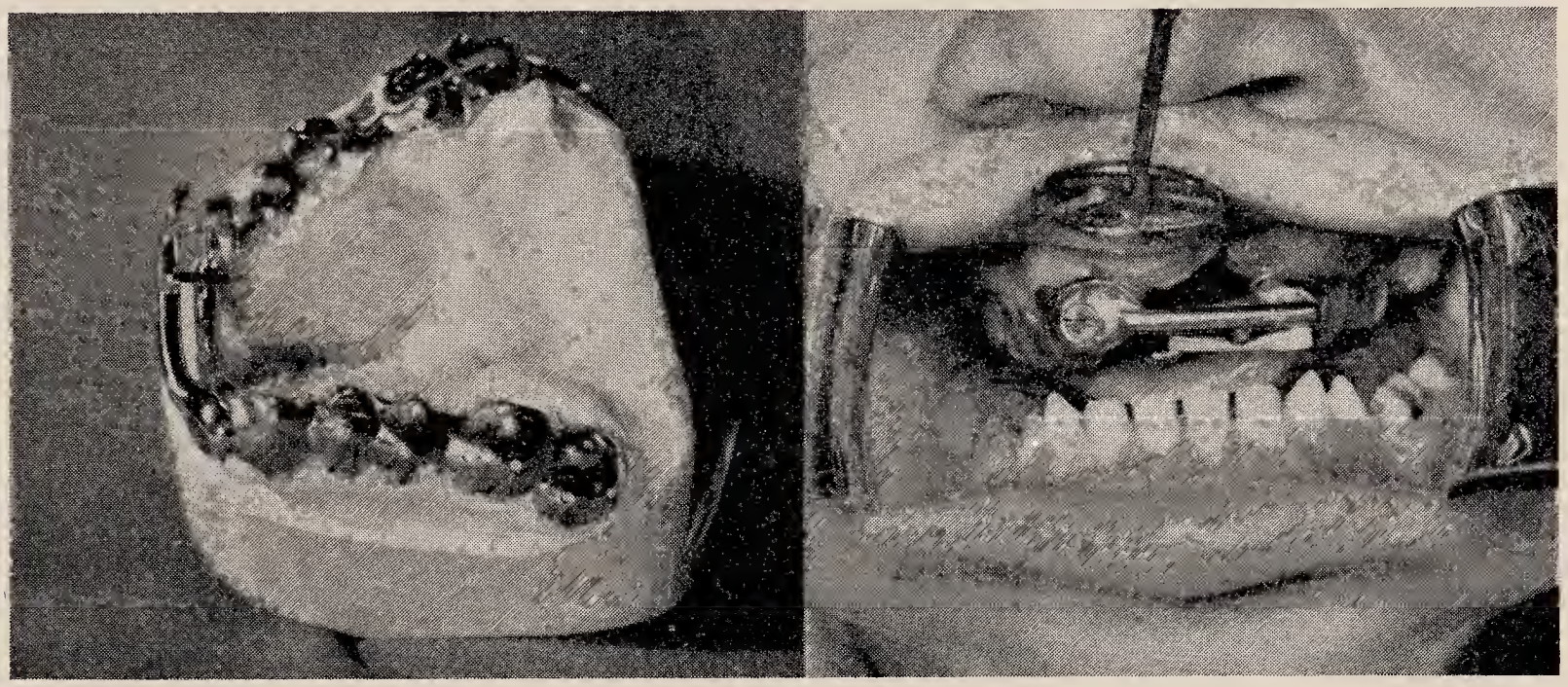

Fig. 8.—Collapsed dental arch associated with a bilateral cleft of the lip and alveolus and a cleft palate. Treated by expansion using splints and elastic traction (A, B). Retained by a fixed bar (C) while a bone-graft seen in D consolidates.

Case 5 (*Figs*. 10–12)

A girl was seen at the age of 6 with mild mandibular prognathism with an anterior open bite and no thumb-sucking or finger-sucking habit. She was observed until the age of 15 when her deformity was no longer progressive. At 15 years of age a mandibular osteotomy in the third molar region was planned. It was appreciated that following osteotomy the retroclined lower incisors would erect themselves and a quite marked over-jet was purposely allowed. Eight months later, following the osteotomy, this over-jet had almost completely disappeared.

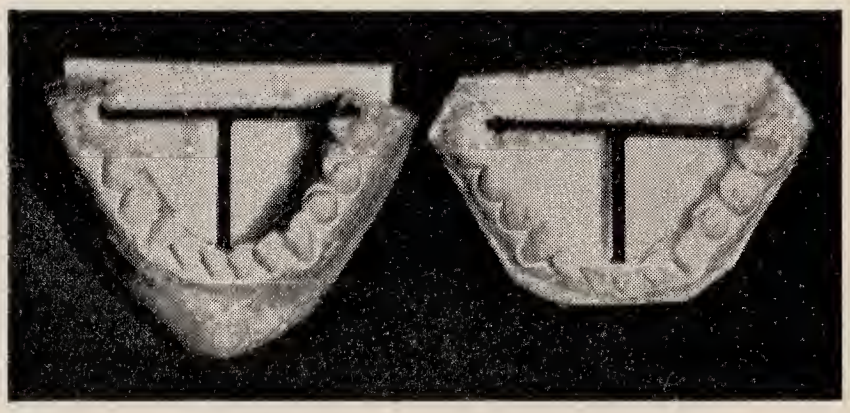

Fig. 9.—Expansion of the lower arch following mandibular osteotomy for the correction of prognathism. The T-piece is a 5-cm. rod on both models.

These secondary dental changes must not be confused with skeletal relapse which can follow

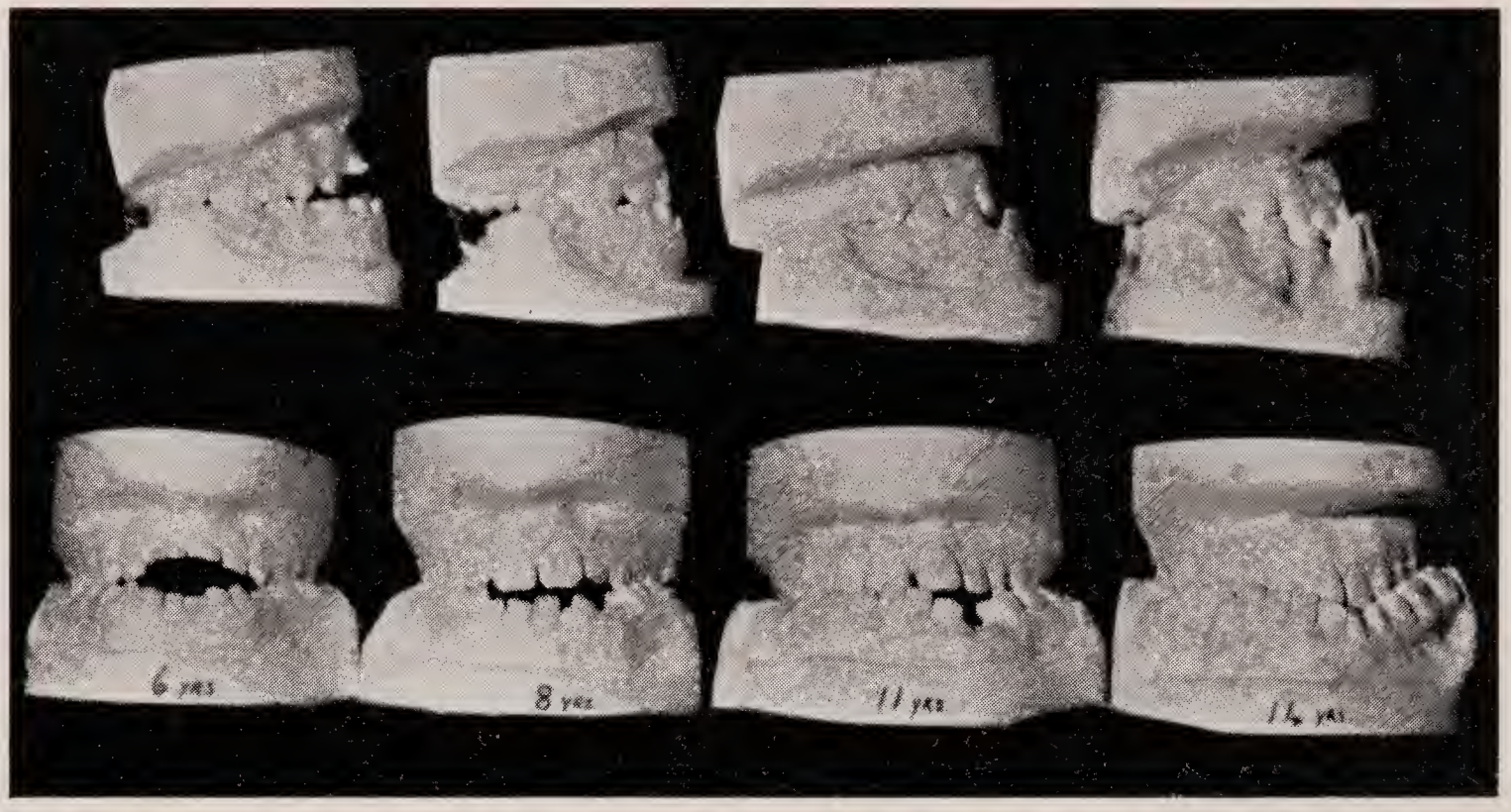

Fig. 10.—The development of mandibular prognathism. The effect of a submerging $\overline{|D}$ in causing a local aberration in the arch is interesting.

Fig. 11.—The same case as in *Fig*. 10, showing the model made up at the planning stage of the osteotomy. The lower incisors are set well back. Eight months after operation the lower incisors have erected themselves to a satisfactory and stable position.

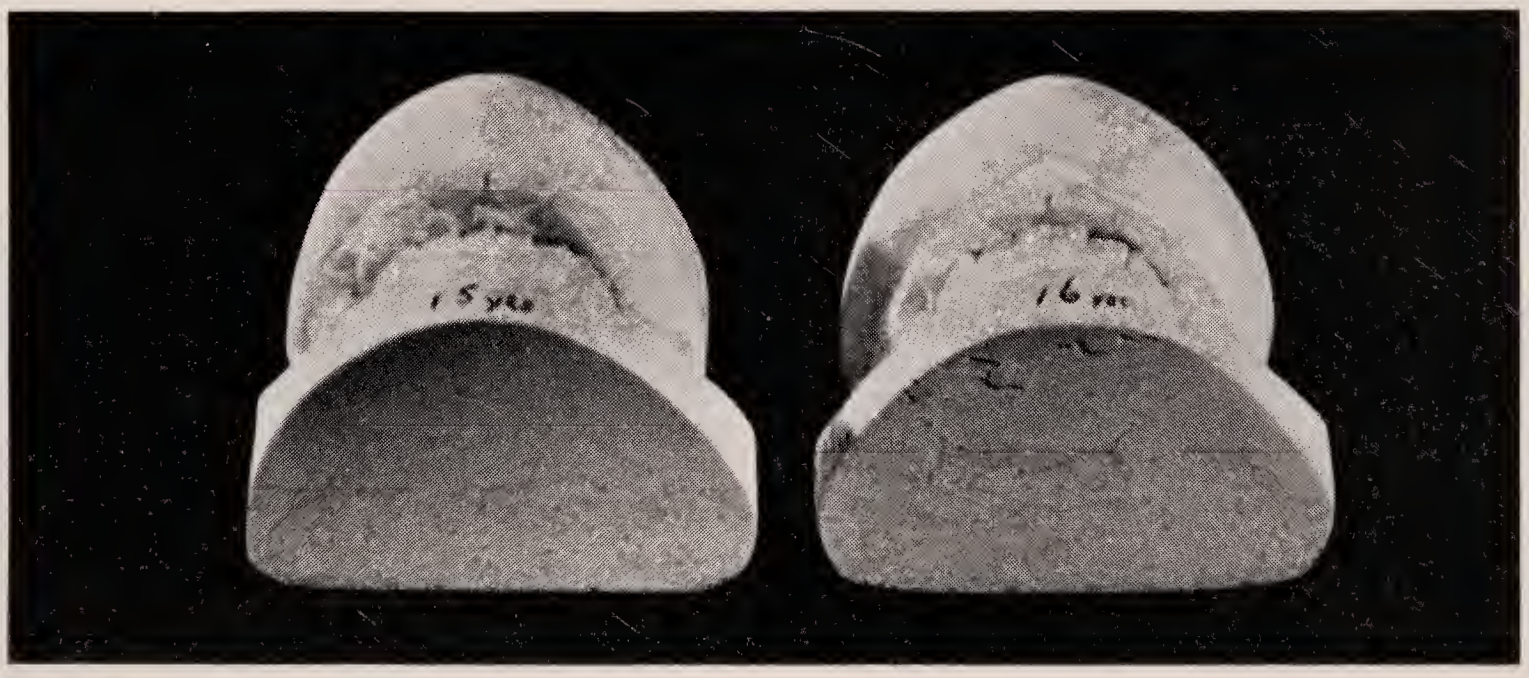

Fig. 12.—Immediate postoperative model showing position of incisors as planned and a follow-up model showing the alteration of axial inclination 8 months later.

the jaw and trauma to it during the formative years should, one would think, interfere with subsequent growth. Some years ago I was surprised to find that children who had suffered fracture of the condyle neck, often with displacement of the condylar head, continued to grow normally and failed to show any mandibular deformity (MacGregor and Fordyce, 1957). I have seen nothing over the ensuing years which would alter my opinion that fractures of the condyle neck, even though associated with dislocation or displacement of the condylar head, do not cause or give rise to any interference with subsequent growth of the jaws. It must be emphasized, however, that in all of these cases where there has been displacement of the main body fragment this has been corrected so that normal occlusion is obtained postoperatively. In none of these cases has there been open surgery or any attempt to correct displacement of a condylar fragment. Serial X-ray examination shows that the condylar head, quite rapidly in the very young, remodels to its normal contour.

Case 6

L. H., aged 3 years, (*Fig.* 13), fell from a window and fractured both condyle necks. The condyle heads were slightly displaced medially and there was a further fracture in the lower left canine region. The fracture of the body was reduced and the jaws immobilized in normal occlusion for three weeks. At a follow-up examination at the age of 11 years it was found that mandibular development had been wholly normal except for failure of eruption of $\overline{|3}$ due to ligature by an interosseous stainless-steel wire. X-ray showed normal condyle contour.

When, then, does trauma cause disturbance of growth, which is quite frequently given in textbooks as the cause of mandibular asymmetry in the adult? Conceivably this could occur where the damage is to the condyle head and not, as is more usual, to the neck of the condyle, or in cases where there is fracture of the articular surface of the condyle head associated with a fracture of the articular fossa. In this set of circumstances, which is not unknown, ankylosis results. Where there is ankylosis in the young there most certainly will follow considerable interference with growth.

A B

Fig. 13.—A, Radiographs of a 3-year-old with bilateral fractures of the condyle necks. B, Follow-up X-rays at 11 years of age.

REFERENCES

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DISCUSSION

Mr. P. R. Barton, opening the discussion, said that Mr. Fordyce had discussed a case in which he had rotated a tooth surgically. This had interested him very much. He had recently had a very interesting four weeks in Zürich, in Professor Obwegeser's clinic, where they were doing routinely a large number of osteotomies involving alveolar movement, moving as few as two or three teeth on their basal bone. He wondered whether Mr. Fordyce had attempted this. It seemed to offer possibly an advantage over surgical movement of the tooth alone, as definite blood-supply was maintained to the tooth that was moved.

Mr. Fordyce had touched on the influence of the tongue on the dental arch in relation to abnormalities of it and in relation to osteotomies. He wished to tempt Mr. Fordyce to say a few words on the sort of

tongue reductions he had found to be effective for large tongues associated with any mandibular osteotomies he had done.

Mr. Fordyce had shown two slides of a mandibular osteotomy which showed a very nice profile following treatment. It seemed to him that one of the problems when reducing a mandibular prognathism was the unfortunate dewlap which was sometimes produced by the soft tissues under the chin. He asked if Mr. Fordyce had found, using different types of osteotomy, one which produced the best profile from this point of view.

Mr. Fordyce said that the problem with alveolar osteotomies was finding enough room to get a cut without coming across another tooth. Some of these procedures certainly worked. The correction of anterior open-bite by sectioning the molar segments and pushing them up into the antrum did not work.

With regard to tongue reduction and the dental arch, he did not think tongue reduction was essential in the treatment of mandibular prognathism if the secondary dental changes that would arise were appreciated. There was a larger potential space behind the tongue in the Class III than there was in the Class II.

With regard to the dewlap effect in the chin and the types of osteotomy, if osteotomy was used far forward, in the ones he had seen the dewlap effect had not occurred. Skin had a peculiar habit of looking after the amount of structure it had to cover; it expanded and, to some extent, contracted.

Mr. C. P. Briggs said that he understood that when Mr. Fordyce transplanted his canines he constructed a splint; how was an impression obtained of the unerupted canine?

Mr. Fordyce said that they waxed it up by eye roughly what the canine should look like, and they overdid it a little, making it good with cement when it was put in. The tooth was pretty firm in the socket. One tapped it in with a hammer, if necessary.

Mr. J. W. Softley said that one might have the impression from the paper that all unerupted canines were either removed or transplanted. He asked if Mr. Fordyce had wished to give this impression, or did he leave some of them alone?

Mr. Fordyce said that he did not want to give that impression at all. He would now be tempted to leave them and use them for transplants, if necessary, but if the arch was complete and the canine was reasonably accessible, he would advise its extraction in a young person, because he saw far too many elderly people with a lot of trouble from canines, in their fifties, sixties, and seventies.

Mr. F. Allan asked why the tooth had to be devitalized; would it be possible to leave it alive?

Mr. Fordyce said that people did this; they took them out and put them back in again without root filling. This went against all he had learnt, but people did it.

Mr. R. J. Thomas referred to the lower labial segment following osteotomy and asked Mr. Fordyce why, if he accepted that the lower labial segment takes up a final position of stability in relation to the soft tissues; and if he felt there might be a relapse following osteotomy to this position, did he bother to overcorrect the position of the lower jaw in relation to the upper. Surely, however much it was overcorrected it would still relapse to the position of stability as governed by soft tissues?

Mr. Fordyce said that if there were retroclined lower incisors, as was usual in Class III cases, and the jaw was put back, then the tongue would try and correct things. If they were merely tucked immediately in behind the upper front teeth, there would be a tendency for them to come forward and there would be a traumatic relationship, so it was as well to put them far enough back to correct themselves. He agreed that the tongue and the lips and the lower jaw would define the position of the lower incisors.

Mr. Thomas asked why Mr. Fordyce over-corrected them. What was achieved by this?

Mr. Fordyce said that the over-correction was to balance the retroclination of the teeth. He wanted to get the teeth at 90°, without skeletal change.

Mr. H. L. Leech asked what was the effect on speech of Mr. Fordyce's Class III osteotomies.

Mr. Fordyce said he had been persuaded on two occasions to do an osteotomy for this very reason and the speech defect had improved right away. He did not recollect a case where speech had been made worse.

Mr. P. M. Benzies asked Mr. Fordyce why he retained these canines in position for ten weeks. Why could it not be two, or four? Why ten?

Mr. Fordyce replied that he based the time on his experience from teeth loosened in conjunction with mandibular fracture.

Mr. Benzies said he thought ankylosis could be avoided if the splint was taken off sooner.

Mr. Fordyce said that Mr. Benzies might be right. Some were ankylosed and some were not, but he thought it was due to damage to the root surface.

Mr. G. B. Winter said that Mr. Fordyce had stated that the amount of resorption that would occur on the tooth was governed by the amount of damage done to the root. He wished to point out that, in fact, Mr. Fordyce was creating the damage by doing his apicectomy. It had been pointed out in the past that resorption might be less—and this was a moot point—if root-filling was carried out from the normal coronal aspect. From his experience of re-implanting upper incisor teeth, the chance of getting subsequent discoloration of the crown from residual pulp was less if the tooth was opened from the coronal aspect and it was easier to get the pulp out.

On the question of operations on children for the removal of teeth which were in an abnormal position in the jaws, he wondered if the *incidence* of trouble in these circumstances ought not to be considered before embarking upon surgery at an early age.

Mr. Fordyce said that he did not think root resorption had anything to do with filling from the top or bottom; the resorption that occurred in such a tooth was lateral tooth resorption; it came in from the sides.

On the question of the incidence of canines that caused trouble later, it was a matter of assessing whether the patient would keep his teeth for the rest of his life. If the patient was to be rendered edentulous and lived long enough, trouble would be caused. It was a question of commonsense. One could not make a rule that all unerupted teeth should be taken out; that would be ridiculous.

Mr. A. C. Campbell said he thought that those present would like to know something of Mr. Fordyce's figures in relation to immediate torsion.

Mr. Fordyce said that his experience in the rotation of central incisors was extremely limited. He had shown fifty per cent of it. The other case had been equally successful.

REPORTS OF MEETINGS

ORDINARY MEETING, 13 January

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 13 January, 1964, at 7.30 p.m., with the President, Dr. W. J. Tulley, in the Chair.

The Secretary (Mr. A. C. Campbell) read the Minutes of the meeting held on 9 December, 1963, which were confirmed and signed as a correct record.

Candidates for Election

The following candidates were elected to membership:—

Miss A. P. Butters, B.Ch.D.(Leeds), 78, Greenway, Southgate, London, N.14.

Mr. I. G. Crossman, B.D.S.(Lond.), L.D.S. R.C.S.(Eng.), 59c, Madeley Road, London, W.5.

Mr. B. F. Reynolds, L.D.S. V.U.(Manc.), Hampton House, 176, London Road, Leicester, Leicestershire.

Mr. G. J. Rubie, L.D.S. R.C.S.(Eng.), 36, Dartford Road, Sevenoaks, Kent.

Miss E. C. Schrotter, B.D.S.(Lond.), 388, Upper Richmond Road, London, S.W.15.

Mrs. A. D. Ward, B.D.S.(Lond.), 186, Wricklemarsh Road, London, S.E.3.

Corresponding Membership

Dr. G. W. Moss, D.D.S.(Univ. of Louisville), 1209, Wilcox Drive, Kingsport, Tennessee, U.S.A.

Mr. V. P. Patel, B.D.S.(Univ. Bombay), c/o Mr. M. M. Patel, 8, Sardar Patel, Nagar, Ellis Bridge, Ahmedabad 6, India.

The President then delivered his Address entitled, '*The Tongue: That Unruly Member* ?'

A vote of thanks to the President was proposed by Mr. R. E. Rix and carried by acclamation.

ORDINARY MEETING, 20 February

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 10 February, 1964, with the President, Dr. W. J. Tulley, in the Chair.

The Secretary read the Minutes of the meeting held on 13 January, 1964, and these were confirmed and signed as a correct record.

Apologies for absence were received from Professor C. F. Ballard, Dr. J. R. E. Mills, Mr. J. D. McEwen, Mr. D. A. Dixon, and Mr. D. Robertson-Ritchie.

Introduction of Members

The following members signed the Register and were introduced to the President:—

Mr. Crossman, Mr. Reynolds, Mrs. Ward, and Miss Butters.

Election of Candidates

The following candidates were elected to membership:—

Mr. J. M. H. Davies, B.D.S.(Lond.), 40, St. Asaph Road, Brockley, London, S.E.4.

Mr. F. J. MacCauley, F.D.S. R.C.S.(Eng.), L.D.S. R.C.S.(Irel.), 129, Castle Avenue, Clontarf, Dublin 3, Eire.

Miss F. A. MacGregor, B.D.S.(Lond.), L.D.S. R.C.S.(Eng.), 13, Oaklands Road, Bromley, Kent.

Mr. J. Metcalf, L.D.S. R.C.S.(Eng.), Glengowan, 14, Station Road, Thames Ditton, Surrey.

Miss A. Potts, L.D.S. R.C.S.(Eng.), Magnolia House, Hankham, Near Pevensey, Sussex.

Mr. C. P. Wilson, B.D.S.(Lond.), 113, Sunderland Road, Forest Hill, London, S.E.23.

Mr. G. A. Kerr then presented a short communication entitled, '*An Orthodontic Case treated with Simple Appliances*'.

The President introduced Mr. C. D. Parker, who delivered the Chapman Prize Essay for 1963: '*A Comparative Study of Intermaxillary Spaces with treated and untreated Occlusions*'.

Following the discussion of the paper, the President presented the Chapman prize to Mr. Parker.

ORDINARY MEETING, 9 March

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 9 March, 1964, at 7.30 p.m., with the President, Dr. W. J. Tulley, in the Chair.

The Secretary read the Minutes of the meeting held on 10 February, 1964, and these were confirmed and signed as a correct record.

Apologies for absence were received from Mr. D. Robertson-Ritchie, Mr. H. I. Cohen, and Mr. J. H. Hovell.

Candidates for Election

The following candidates were elected to membership:—

Mr. A. M. Cookson, B.D.S.(U.B'Ham), D.Orth. R.C.S.(Eng.), Field House, Maisemore, Gloucester.

Mr. P. R. W. Coyle, L.D.S.(L'pool), Devon Villa, St. Paul's Road, Newton Abbot, Devonshire.

Corresponding Membership

Dr. Henry W. Jann, D.D.S.(U. Buffalo), M.A. (U. Buffalo), Prof. Cert. Ortho.(U. Buffalo), 27, Briarwood Drive, Rochester, New York, U.S.A.

The PRESIDENT then introduced Professor K. P. Liddelow who read his paper entitled, '*Oral Muscular Behaviour*'.

SCIENTIFIC MEETING, 21 May

A SCIENTIFIC MEETING of the Society was held in the Scott Lecture Theatre, Central Library, Plymouth, on Thursday, 21 May, 1964. The President (Dr. W. J. Tulley) took the chair, and Research Reports were presented according to the following programme:—

'*Cine-radiographic study of Tongue, Hyoid Bone, and Mandible during Deglutition*', by P. M. Benzies.

'*Postulated Pre-natal Aetiology of Maxillary Asymmetry*', by E. K. Breakspear.

'*Nasal Obstruction and Tongue Behaviour*', by A. J. P. Cousins.

'*The Measurement of Pressures exerted on the Teeth by the Perioral Musculature*', by M. S. E. Gould and D. C. A. Picton.

'*A Cephalometric Analysis of the Relapse of Upper Incisors in Class II, Division 1 Cases following Treatment*', by D. G. Huggins and R. H. Birch.

'*The Relationship between Loss of First Permanent Molars and Caries*', by J. D. McEwen, W. D. McHugh, and A. D. Hitchin.

'*Classification of Malocclusion based on Morphology*', by G. H. Steel.

Each report was followed by a discussion.

COUNTRY MEETING, 22 and 23 May

The PRESIDENT (Dr. W. J. Tulley) welcomed delegates to the Country Meeting.

THE SECRETARY read the Minutes of the previous meeting, which were confirmed and signed as a correct record.

Apologies for absence were received from Mr. J. F. Pilbeam, Mr. R. A. Campbell, Miss Patricia Miller, and Mr. N. F. Wood.

Candidates for Election

The following candidates were elected to membership of the Society:—

Mr. J. Catcheside, B.D.S.(U. Durh.), D.Orth. R.C.S.(Eng.), 2, Queen's Parade, Bath, Somerset.

Mr. J. J. Horton, L.D.S.(U. Birm.), Dene End, Deneside, Eastdene, Eastbourne, Sussex.

Mr. K. G. Isaacson, L.D.S. R.C.S.(Eng.), Chearsley Vicarage, Aylesbury, Buckinghamshire.

Mr. P. Vig, B.D.S.(U. Sydney), F.D.S., D.Orth. R.C.S.(Eng.), 1, Hillside Gardens, London, N.6.

Corresponding Membership

Dr. R. O. Croll, 4652, West 10th Avenue, Vancouver 8, British Columbia, Canada.

President's Introduction

The PRESIDENT welcomed visitors to the Country Meeting after which the papers and demonstrations were given according to the following programme:—

Friday, 22 May

9.45 a.m. Short Communication: Mr. E. S. Broadway: '*Two Unusual Cases of Facial Asymmetry*'.

10.00 a.m. Short Communication: Mr. M. L. Brenchley: '*The Extraction of an Upper Lateral Incisor as part of Orthodontic Treatment*'.

Chairman: Professor D. P. Walther.

10.30 a.m. Short Communication: Mr. A. J. Walpole Day: '*Tongue-sucking in an Adult Patient*'.

11.00 a.m. Coffee.

11.30 a.m. Paper: Professor R. E. Moyers: '*An American View of Removable Appliances*'.

The President in the Chair.

12.30 p.m. Lunch.

2.00 p.m. Demonstrations: Mr. G. H. Roberts: '*Incidence of Need for Extraction Therapy*'. Mr. I. F. Davidson: '*The Use of a Punch-card Index and Filing System to Record Orthodontic Case Histories*'. Mr. D. A. Dixon: '*A Profilometer*'. Mr. S. Haynes: '*A Study of Some Conventional and Unconventional Orthodontic Screws with Some Practical Recommendations concerning their Use*'. Dr. W. J. Tulley and Mr. B. S. Cryer: '*An Assessment of the Importance of Tongue and Lip Activity*'. Mr. B. C. Leighton: '*Fabrication of the Modified Pin-and-tube Appliance*'. Dr. W. Grossmann and Mr. J. P. Moss: '*Functional Appliance Therapy*'. Mr. G. H. Steel: '*Colour Transparencies showing Stages of Treatment*'. Mr. J. D. Atherton, Dr. W. R. Burston, and Mr. L. F. Gore: '*The Demonstration of Embryonic and Adult Bone using a Solid Resin Embedding Technique*'. Mr. M. L. Brenchley: '*An Appliance for the Rotation of Upper Molars*'. Mr. W. J. Selley: '*Clinical Photography*'. Mr. V. S. Iyer: '*Biting Platforms in Orthodontic Appliances*'. Mr. R. D. Howard: '*Management of Unerupted Teeth*'. Mr. J. H. Martin and Mr. J. D. McEwen: '*Teaching Aids for Undergraduates*'.

4.00 p.m. Tea.

7.30 p.m. for 8.15 p.m. Society Dinner—Duke of Cornwall Hotel.

Saturday, 23 May

9.30 a.m. Symposium: Dr. J. R. E. Mills, Dr. W. Grossmann, and Mr. G. C. Dickson: '*Functional Therapy*'.

The President in the Chair.

11.00 a.m. Coffee.

11.30 a.m. Discussion on Symposium.
12.30 p.m. Lunch.
2.00 p.m. Short Communication: Mr. I. F. Davidson: '*A Case of Class II, Division 1 Malocclusion*'.
Chairman: Mr. A. Gordon Taylor.
2.30 p.m. Short Communication: Professor C. F. Ballard and Captain J. B. Wayman: '*A Report on a Survey of the Orthodontic Requirements of 310 Army Apprentices*'.
3.00 p.m. Paper: Mr. J. D. Atherton: '*The Influence of the Face Height upon the Incisor Occlusion and Lip Posture*'.
The President in the Chair.
4.00 p.m. Tea.

ORDINARY MEETING, 12 October

AN ORDINARY MEETING of the Society was held on Monday, 12 October, 1964, at 7.30 p.m. at Manson House, 26, Portland Place, London, W.1, with the President, Professor W. J. Tulley, in the Chair.

The CHAIRMAN reported with regret the death since the last meeting of Mr. F. Bocquet Bull; Mr. Bocquet Bull was a respected member of the Society and a Past President. He asked members to stand for a moment in respect.

Members stood for a moment in silent tribute.

The SECRETARY read the Minutes of the Seventh Country Meeting. These were confirmed and signed as a correct record.

Apologies for absence were received from Mr. M. A. Burley and Mr. C. P. Briggs.

The CHAIRMAN reminded members that it was their privilege to nominate members to the Council. These had to be signed by four properly qualified members and should be received by the Secretary seven days before the next meeting.

The following members, who were elected at a previous meeting, were introduced to the Chairman:—

Mr. G. J. Rubie, Mr. J. J. Horton, Mr. P. Vig.

Candidates for Election

The following candidates were elected to membership:—

Mr. T. A. Connolly-Meagher, L.D.S. R.C.S I., Royal Dental Hospital, Leicester Square, London, W.C.2.

Mr. M. J. Furness, B.D.S.(Lond.), 3, Ingleby Way, Wallington, Surrey.

Mr. V. S. Iyer, B.D.S.(Bombay), L.D.S., D.D.O.(Glasgow), F.D.S. R.C.S. (Edin.), School of Dental Surgery, The University, Sheffield 10.

Mr. H. Leon, B.D.S.(Lond.), 40, Highfield Grove, Stafford.

Miss M. T. N. MacAlpine, B.D.S.(Glasgow), 4A, Montpelier Avenue, Ealing, London, W.5.

Mr. J. D. H. McDonald, B.D.S.(Queensland), D.Orth. R.C.S.(Eng.), Royal Dental Hospital, Leicester Square, London, W.C.2.

Mr. J. P. Moss, B.D.S.(Lond.), F.D.S., D.Orth. R.C.S.(Eng.), 8, Langdon Drive, London, N.W.9.

Mr. P. I. Townend, L.D.S., B.Ch.D.(Leeds), 7, Wylde Green Road, Sutton Coldfield, Warwickshire.

The CHAIRMAN said that it gave him great pleasure to announce the decision of the Council that the Chapman Prize for 1964 be awarded to Mr. G. H. Steel for his essay entitled, '*The Relation between Dental Maturation and Physiological Maturity*'.

The CHAIRMAN then invited Mr. J. D. Hooper to read his short paper entitled, '*Simple Fixed Appliances*'.

This was followed by a paper by Mr. E. S. Broadway, '*Mechanical Failure*', after which Mr. J. R. Pettman read a paper entitled, '*The Timing of Orthodontic Treatment in Relation to Psychological Development*'.

ORDINARY MEETING, 9 November

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 9 November, 1964, at 7.30 p.m., with the President, Professor W. J. Tulley, in the Chair.

The SECRETARY read the Minutes of the meeting held on 12 October, 1964, which were confirmed and signed as a correct record.

Candidates for Election

The following candidates were elected to membership:—

Mr. B. D. Aron, L.D.S., D.Orth. R.C.S.(Eng.), 19, Hope Road, Prestwich, Manchester.

Mr. R. A. Collins, L.D.S. R.C.S.(Eng.), 90, Willingdon Park Drive, Eastbourne, Sussex.

Mr. W. L. Dickson, L.D.S.(U. Manc.), 18, Glebe Road, Welwyn, Hertfordshire.

Mr. B. A. Foster, B.D.S.(Lond.), L.D.S. R.C.S. (Eng.), 35, Bridge Street, Belper, Derbyshire.

Corresponding Membership

Dr. Lamar A. Bell, D.D.S.(U. Penn.), 2437, N. 50th, Philadelphia, Pennsylvania, U.S.A.

Dr. P. P. Fransblow, D.D.S.(Dalhousie), D.Orth. R.C.S.(Eng.), 929, West Georgia Street, Vancouver 1, British Columbia, Canada.

Mr. L. C. Kung, B.D.S.(Malaya), 103, Free School Road, Penang, Malaya.

Mr. K. L. Mak, B.D.S.(Malaya), 16, Wilson Road, 1st Floor, Jardine's Lookout, Hong Kong.

Apologies for absence were announced from Mr. J. D. McClure.

Mr. K. G. Isaacson was admitted a member of the Society and welcomed by the President.

The PRESIDENT then introduced Professor A. G. Brodie who gave the eighteenth Northcroft Memorial Lecture entitled, '*Muscles, Growth, and the Apical Base*'.

A vote of thanks to Professor Brodie was proposed by the PRESIDENT and carried by acclamation.

ANNUAL GENERAL MEETING, 14 December

THE ANNUAL GENERAL MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 14 December, 1964, at 7 p.m., with the President, Professor W. J. Tulley, in the Chair.

THE PRESIDENT announced with regret the death of two faithful friends of the Society and old members, Mr. Stanley Willis and Mr. Wynne. Mr. Willis had been a member for many years and Secretary of the European Orthodontic Society. Mr. Wynne had been Honorary Auditor.

Members stood for a moment in silent tribute.

Apologies for absence were received from Professor C. F. Ballard, Mr. D. A. Dixon, Mr. J. D. McEwen, and Mr. R. A. Campbell.

The Minutes of the previous meeting were read by the Secretary and signed by the President as a correct record.

The Society's Financial Year

Mr. A. Gordon Taylor proposed, ' That the period from the Annual General Meeting in December, 1965, until May, 1966, should be considered a full year in the administration of the Society with the financial year ending on 31 December, 1966. Subsequently, the financial year should be from 1 January to 31 December in each year '.

The resolution was seconded by Mr. R. E. Rix and carried unanimously.

Changes in Bye-laws

The PRESIDENT said that following the Resolution, a number of minor changes had to be made in the Bye-laws which were set out in the agenda. He assured members that the amendments to Bye-laws 17, 19, 46, and 48 were necessary to bring the resolution into operation.

Mr. R. E. Rix proposed the following changes in the Bye-laws:—

No. 17. Delete 'Annually' and 'in December', and add ' Annual General ' so that the Bye-law shall read, ' The Officers, Councillors and two Auditors shall be elected from the Ordinary Members, by Ballot at the Annual General Meeting, and all Members residing within the British Isles shall be summoned to this Meeting by letter, a week's notice being given, and the hour of meeting stated '.

No. 19. Delete ' before the Annual General Meeting ' and add ' in March ', so that the Bye-law shall read, ' Nominations to the Council shall be made by the Council and Nominations may also be made by post by four properly qualified Members if received by the Secretary at least seven days prior to the Ordinary Meeting in March '.

No. 46. Delete ' The month of December ' and insert ' normally ' and ' May ' so that the Bye-law shall read, ' The Annual General Meeting of the Society for the election of Officers and Councillors, and for the reception of the Annual Reports of the Treasurer and other Officers and any other business, shall normally be held in May every year '.

No. 48. Delete ' in December ' so that the Bye-law shall read, ' New Bye-laws shall be proposed by the Council only, either at the Annual General Meeting of the Society, or at a Special Meeting convened for that purpose. Notice of the proposed new Bye-law or Bye-laws shall be sent to all Members residing within the British Isles with the summons to such Meeting. For the adoption of each Bye-law proposed, the vote of two-thirds of the Members present shall be required in its favour '.

The resolution was seconded by Dr. J. R. E. Mills and carried unanimously.

The PRESIDENT said he thought that the proposal would be of great benefit to the Society. The Council could think of no factors against it.

Bye-law 16

The PRESIDENT said that for the past three years a Councillor of the Society had been acting as Assistant Secretary. This had proved of great assistance to the work of the Council, who proposed that the post of Assistant Secretary be added to the number of Officers of the Society. They therefore proposed that Bye-law 16 be amended to allow of the inclusion of a new Assistant Secretary.

Mr. E. J. R. Bird proposed:—

' That Bye-law 16 be amended as follows: Add "an Assistant Secretary" so that the Bye-law shall read, "The Officers of the Society shall be elected from the Ordinary Members, and shall consist of a President, an Immediate Past-President, a President-Elect, a Senior Vice-President, a Treasurer, a Secretary, an Assistant Secretary, an Editor, a Curator and a Librarian. These with five other Members, who shall be called Councillors, shall constitute the Council and shall have the management of the Society's affairs.

' At least three members of the Council shall be resident outside the London area.

' All members of the Council shall act in an honorary capacity " '.

The proposal was seconded by Mr. B. C. Leighton and carried unanimously.

Treasurer's Report

The HON. TREASURER (Mr. J. S. ROSE) reported that during the past year the Society's income had been similar to the previous years, but expenses had increased. The additional expenditure was accounted for in three basic items: the honorarium for the Northcroft Memorial Lecture had been doubled by the decision of the Council; the Country Meeting costs had increased; and secretarial expenses had risen as anticipated. He was again indebted to the Honorary Librarian for valuable help in the sale of the Society's Transactions.

On the proposal of Mr. J. S. Beresford, seconded by Mr. J. D. Hooper, the report was adopted.

Secretary's Report

The HON. SECRETARY (Mr. A. C. CAMPBELL) reported that it was now one year since Mr. Leighton has passed the secretarial duties over to him and he would like to thank him for the help and guidance which he had always been ready to give during the previous twelve months.

The Society continued to grow, and at the end of 1964 the total membership was expected to be 560. We had lost 4 members by death and 9 by resignation, whilst we had been joined by 36 new Ordinary and 9 new Corresponding Members, showing a net increase of 32 over the year.

Seven meetings had been held during the year, and the average attendance of 113—which may be a record—gave an indication of Members' interest in the programme. At this stage, he would like to express his thanks to Mr. Burley and Mr. Briggs for all the untiring work which they put into the organization of the Country Meeting in Plymouth, which would be remembered not only for an interesting programme, but also for a very lively Annual Dinner.

During the past year the Council had been much concerned with proposals for changing the Society's year and for reinforcing the Secretariat, both of which had been foreshadowed in Mr. Leighton's report last year. A further point which had been carried forward was the question of the time of meetings which would be considered again later in the evening's Agenda. The Council had also recently set up a Sub-committee to consider the Society's relationship with the growing number of Regional Orthodontic Study Groups.

During the year, changes had been made in the form of the Agenda sheets—partly to present a more contemporary note—but also in an attempt to ensure that Society Notices were seen by Members. In the past, smaller sheets had made it necessary for some items to be printed on the back, with the result that they were often not read. It was hoped that Members would also approve changes in the form of the Annual Programme shortly to be circulated.

He would like to repeat the remarks of his predecessors that the Council was always anxious to consider offers of papers from Members for inclusion in the programme, whether these were of a practical or theoretical content.

On the proposal of Mr. B. C. Leighton, seconded by Mr. R. W. Willcocks, the report was adopted.

Editor's Report

The HON. EDITOR (Dr. J. R. E. MILLS) then reported that the Society's *Transactions* had continued to be published in the *Dental Practitioner*, as well as in bound form. As members would have noticed, the publishers had somewhat changed the format of this Journal, using a new type face, in September at the beginning of their Volume 15. This meant that the first of the 1964 TRANSACTIONS had to be delayed until September in order to avoid a change of format within the bound TRANSACTIONS and publication was consequently rather delayed. Both the publishers and he would endeavour to rectify this as soon as possible.

He was sorry that members had not yet received their TRANSACTIONS for 1963. These were originally promised for November, but he had now received a revised publication date, for early January, 1965.

The adoption of the report was proposed by Mr. P. H. Burke and seconded by Mr. J. D. Hooper and this was carried.

Librarian's Report

The HON. LIBRARIAN (Mr. D. I. SMITH) reported that the Society's Library was still housed next door to Manson House in the Institute of Public Health where Members could borrow books, journals, and past TRANSACTIONS.

The Library also sold current and past TRANSACTIONS. The demand for these continued to increase.

He wished to express the Society's gratitude to those who had presented TRANSACTIONS and journals to the Society.

On the proposal of Mr. R. D. Howard and Mr. R. E. Rix the report was adopted.

Curator's Report

The HON. CURATOR (Mr. B. C. LEIGHTON) reported that his first year of office as Curator had been uneventful. It was customary for the Curator to remind the members each year that the museum may be visited at No. 28 Portland Place. He would be very glad to show the Museum and its catalogue to any member who wished to see them. There were excellent collections of serial study models, and morphologically classified abnormalities. A further collection of appliances which were of historical interest had been started, but was still very incomplete. If any member were to make contributions under the headings they would be received most gratefully.

The adoption of the report was proposed by the President and carried.

Election of Officers

The following Officers and Councillors were elected:—

President:	Mr. A. J. Walpole Day
Immediate Past President:	Professor W. J. Tulley
President-Elect:	Mr. R. E. Rix
Senior Vice-President:	Mr. J. W. Softley
Vice-President:	Mr. J. D. Hooper
Councillors:	Mr. D. A. Dixon
	Mr. M. A. Kettle
	Mr. J. D. McEwen
	Mr. W. A. Nicol
	Mr. N. R. E. Robertson

Treasurer:	Mr. J. S. Rose
Secretary:	Mr. A. C. Campbell
Assistant Secretary:	Mr. C. P. Briggs
Editor:	Dr. J. R. E. Mills
Curator:	Mr. B. C. Leighton
Librarian:	Mr. D. I. Smith

On a motion proposed by Mr. A. G. Taylor, seconded by Mr. S. G. McCallin, Mr. P. H. Burke and Mr. J. F. Pilbeam were elected as Hon. Auditors.

The PRESIDENT said that the question of the time of meetings had been raised at the last Annual General Meeting. Despite the anxiety expressed by some members, the Secretary had had very small response to requests for letters suggesting new times. The Council had given considerable thought to this, and because of the small number of letters really asking for a change of time, they had decided for at least the next year to let things remain as they were.

After some discussion, Mr. M. F. Scott and Mr. J. F. Pilbeam proposed ' That the time of meetings be changed to 5.30 p.m. '. After further discussion the motion was put to the meeting and lost.

The PRESIDENT promised that the Council would discuss the matter further.

The meeting then terminated.

ORDINARY MEETING, 14 December

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 14 December, 1964, following the Annual General Meeting. The President, Professor W. J. Tulley, occupied the Chair.

The Minutes of the Ordinary Meeting held on Monday, 9 November, 1964, were read by the Secretary and signed as a correct record.

Mr. B. D. Aron, whose election had been confirmed, was introduced to the President.

The PRESIDENT announced the Council's nomination of Dr. John Campbell for Honorary Membership of the Society. Dr. Campbell had done a tremendous amount of work in research and he was sure that members would approve this.

Candidates for Election

The following ordinary members were elected to membership:—

Mr. A. Richardson, B.D.S., D.P.D.(U. St. Andrews), D.Orth. R.C.S.(Eng.), 33, Cherryvalley Park, Belfast 5.

Mrs. M. E. Richardson, M.Dent.Sc.(U. Dubl.), D.Orth. R.C.S.(Eng.), 33, Cherryvalley Park, Belfast 5.

Miss B. Taylor, L.D.S.(Q.U.Belf.), 6, University Terrace, Belfast 9.

Mr. A. J. Wilson, L.D.S.(U.L'pool), D.Orth. R.C.S.(Eng.), 29, Holmwood Gardens, Victoria Park, Freshfield, Formby, Lancashire.

Corresponding Membership

Mr. Leong Cheok Tho, L.D.S. R.C.S.(Edin.), D.Orth. R.C.S. (Eng.), 89, Jalan Raia Timor, Klang, Selangor, Malaysia.

The PRESIDENT then invited Mr. G. L. Fordyce to read his paper entitled, '*Surgical Problems of Orthodontic Interest*'.

Vote of Thanks to Retiring President

Following the discussion, a Vote of Thanks to the retiring President was proposed by Mr. J. S. BERESFORD and carried with prolonged acclamation.

Valedictory Address

The retiring PRESIDENT said that valedictory addresses should be short, sweet, and somewhat sorrowful. He would like to thank Mr. Beresford for his kind remarks and to say that it had been an honour and a privilege to have held this office. The year had gone so quickly that their year's resolutions had not all been achieved. A President could do nothing without the support of his Council, and they had been exceptionally patient with him.

He would like to thank Dr. Mills, the Editor, for the way he had struggled patiently with the TRANSACTIONS and controlled the Editorial Committee. He had every reason to believe that the Society's TRANSACTIONS were regarded very highly abroad, particularly the way in which discussion was published fully and frankly.

He would particularly like to thank the Secretary, Mr. A. C. Campbell, and the Treasurer, Mr. J. S. Rose, who supported him, one on either side of the platform. This had been a very special pleasure for him because they had been friends for many years and contemporaries at hospital. He could not thank them enough for the many hours of their own time which were taken up with the work of the Society. This went for all the other officers and members of the Council.

They had had some stimulating Council meetings and had managed to change the look of the programme printing and the Agenda sheets. They had made progress in organizing the Society's year.

He had to say a special ' thank you ' to Mr. Gordon Taylor who now retired from the Council, having been a member for twenty-nine years.

As a learned Society, they did not seek to enter the realms of dental politics, but with the Council's permission, Mr. Leighton and he had given evidence before the Standing Dental Advisory Committee.

There was no doubt that as the Society grew in size, they would have to seek other accommodation and increase the facilities for the Library and Museum.

It was a very pleasant duty to hand over the badge of office to Mr. Walpole Day.

The retiring President then invested Mr. A. J. Walpole Day with the Insignia of Office as the Society's President.

Mr. A. J. Walpole Day said that no man could be elected and installed as President of the Society without being very conscious of the great honour bestowed upon him. He was no exception to this rule. All he could say was that he would endeavour to justify the trust placed in him by doing everything he could to continue to run the Society in the way to which members were accustomed for it to be run. He was grateful to the retiring President for his kind words of introduction.

It was his duty to announce the date of the next meeting, which was on 11 January, 1965, at 7.30, when the Presidential Address would be read with the title, '*There is a Divinity that shapes our Ends*'.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and Income and Expenditure Sheet

FOR THE YEAR ENDING SEPTEMBER 30, 1964

FREDK. B. SMART & COMPANY, CHARTERED ACCOUNTANTS
22 Queen Street, London E.C.4

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

INCOME AND EXPENDITURE ACCOUNT for the year ended 30th September, 1964

1963 £	£		£ s. d.	£ s. d.
11		To Museum Rent		10 10 0
		,, *Meeting Expenses:—*		
	49	Hire of Hall	46 13 0	
	65	Refreshments	73 14 8	
	123	Reporting	156 14 0	
	6	Lantern and Films	7 17 0	
	79	Country Meeting (Net) ..	132 18 11	
	29	Northcroft Memorial Lecture	52 10 0	
351	——		———	470 7 7
26		,, *Chapman Prize*		26 5 0
		,, *Printing:—*		
	775	Publications	827 7 7	
	197	General Printing and Stationery	186 12 4	
972	——		———	1013 19 11
15		,, *Library and Journals*		3 0 0
75		,, *Postage*		62 13 6
107		,, *Secretarial Assistance*		156 0 0
22		,, *Honoraria*		15 15 0
37		,, *Accountancy*		36 15 0
4		,, *Insurance*		4 15 9
7		,, *Sundry Expenses*		6 16 3
		,, *Depreciation of Furniture and*		
30		*Equipment*		22 0 0
		,, *Excess of Income over Expendi-*		
504		*ture for the year*		353 8 2
£2161				£2182 6 2

1963 £	£		£ s. d.	£ s. d.
		By *Members' Subscriptions:—*		
	1525	Subscriptions	1634 15 4	
	91	Arrears Collected	17 17 6	
1616	——		———	1652 12 10
268		,, *Sale of Transactions*		207 3 9
		,, *Interest Received and Accrued:—*		
	42	Savings Certificates	50 0 0	
	19	5¼% Hertford C.C. Stock (net)	19 5 10	
	16	5¼% Corporation of London Stock (net)	16 1 8	
	22	3% Funding Stock (net) ..	21 13 8	
	50	5% Defence Bonds	50 0 0	
	1	P.O.S.B.	8 6	
	8	Bank Deposit Interest ..	15 1 1	
	23	J. & P. Coats, Patons and Baldwins Ltd. (net) ..	17 12 3	
	10	City of London Real Property Co. Ltd. (net)	11 5 4	
	17	British Insulated Callenders Cables Ltd. (net)	16 14 5	
	10	Royal Insurance Co. Ltd. (net)	9 14 0	
218	——		———	227 16 9
		,, *Income Tax:—*		
—		Balance recovered to 5th April 1963	1 0 6	
59		Recoverable to date	93 12 4	
			———	94 12 10
£2161				£2182 6 2

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

BALANCE SHEET as at 30th September, 1964

1963 £	£		£ s. d.	£ s. d.
		Accumulated Fund:—		
	4757	Balance as at 1st October 1963 ..	5260 16 7	
	504	*Add*: Excess of Income over Expenditure for the year	353 8 2	
	—	City of London Real Property Co. Ltd. Capital Distribution ..	1 18 4	
5261				5616 3 1
		Creditors and Reserves:—		
	1810	Publications printing reserves (estimated by Hon. Treasurer) ..	1810 0 0	
	26	Northcroft Memorial Lecture ..	52 10 0	
	13	Hire of Hall	13 10 0	
	11	Museum Rent	10 10 0	
	49	Subscription in Advance	42 6 0	
	6	Petty Cash Accounts	6 13 6	
	37	Accountancy	36 15 0	
	—	Secretarial Services	66 0 0	
	—	Chapman Prize (1963)	26 5 0	
1952				2064 9 6
£7213				£7680 12 7

P. BURKE
J. F. PILBEAM } *Hon. Auditors*
J. S. ROSE *Hon Treasurer*

1963 £	£		£ s. d.	£ s. d.
		Fixed Assets:—		
	120	Furniture and Equipment Balance at 1st October, 1963	90 0 0	
	30	*Less* Depreciation	22 0 0	
90				68 0 0
		Investments at Cost:—		
	1034	1200 National Savings Certificates plus accrued interest	1083 6 8	
	1000	£1180 3% Funding Stock 1959/69	1000 5 0	
	1000	£1000 5% Defence Bonds ..	1000 0 0	
	597	£600 5¼% Hertfordshire County Council 1965	597 9 6	
	509	£500 5¼% Corporation of London 1976/79	508 10 9	
	502	230 J. & P. Coats, Patons and Baldwins Ltd. £1 Ordinary Shares	502 3 6	
	478	£115 City of London Real Property Co. Ltd. Ordinary Stock ..	478 17 9	
	455	£182 British Insulated Callenders Cables Ltd. Ordinary Stock ..	455 2 5	
	479	£50 Royal Insurance Co. Ltd. Stock	478 10 0	
6054				6104 5 7
		(Approximate Market Value at 30.9.64 £6173.10.5)		
96		*Income Tax Recoverable*		93 12 4
		Cash at Bank:—		
	452	Westminster Bank Limited ..	395 9 3	
	17	P.O.S.B.	17 6 11	
	500	Deposit Account	1000 0 0	
969				1412 16 2
4		*Cash in Hand*		1 18 6
£7213				£7680 12 7

Certified in accordance with the Books and Vouchers of the Society.
We have verified the Investments and Cash at Bank.
FREDK. B. SMART & CO.,
Chartered Accountants,
22, Queen Street, London, E.C.4.

3rd November, 1964.

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